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THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

VOL. XXV. OCTOBER 4, 1889. No. 619.

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ELECTRIC TRACTION.

WHEN is that good time coming when electric traction will take firm root in our large English cities? Periodically we are called upon to take a trial trip upon an electrically-propelled car constructed under the patents of some promising system, and almost invariably the experimental runs are so successfully performed that one concludes, after an examination of the machinery, that there exists no obstacle whatever to the immediate employment of these horseless vehicles. In spite of the fact that experience has shown them to be quite trustworthy so far as their daily running is concerned, and inasmuch as statistics from America have shown that electric traction is the cheapest method of propelling tramcars, yet we seem to be no nearer to the ultimate object of our desires than when Radcliffe Ward made his preliminary experiments some years ago at Leytonstone. In this, as in most new enterprises, England will be about the last to take it up; but when that happy day arrives it is to be hoped that the pioneers of an industry which has such a great future will be amply rewarded for their weary years of waiting. We have recently learned that a well-known company in London has received an order for electric cars to be used in Australia to the extent of £45,000, and that the Thomson-Houston people in America have just added to their already large contracts another of ten times the sum just named. Still, we are desirous of seeing electric traction thrive nearer home, and there is just the hope that the London Tramways Company may shortly introduce Jarman's system upon their South London lines.

It was only on Tuesday night last that we made a series of lengthy trips on the experimental car of Mr. Jarman, which has now been in intermittent use for nearly three years, and which still appears to be capable of withstanding any amount of hard usage. The distances covered were the greatest we have hitherto been privileged to travel in this manner, and the road was not in a state which might be called perfect, yet everything which we could think of to try the efficiency of the car was performed over and over again with ease, and we were much pleased with the results of our nocturnal expedition which ran into several hours. Our readers are aware that Mr. Jarman employs a double armature motor and accumulators; therefore it is not necessary to enter into any details concerning the electrical features of the car. A new vehicle is just on the point of completion which will be much lighter than that which has had to bear the brunt of the last three years' labour, and this, it is hoped, will shortly be running. Mr. Jarman believes that before long he will have six cars—the minimum number which he thinks it possible to work below the cost of horse traction—in daily operation, and we only hope that his supporters will carry him through to a triumphant issue. If he can imbue them and the directors of the Tramway Company with a little of his own enthusiasm for awhile we shall see electric locomotion at last making a fair start in the metropolis, and when one line can show a saving on its present mode of working, others will be only too glad to follow.

LEGISLATION WANTED.

WE have been taught to believe that the days of miracles no longer exist, but if the extraordinary statements which are going the round of the daily press respecting the doings of Professor Edward Moross, ex-officer in the Army, are allowed to go uncontroverted or unexplained, the public will believe that we have once again in our midst a miracle worker. The name of the gentleman is familiar to those of our readers who but a short time since followed the case of Moross *v.* Parkes, and he now presents himself before the Metropolitan public as the pre-eminent and renowned medical electrician. We had hoped that the unwary would have been misled by but one of these gentry, but there are now two Richmonds in the field, and the new comer bids fair to oust the Oxford Street practitioner from the proud position he has occupied for so long. The Professor's system is unique, unrivalled. It differs from all others, and no longer will sufferers need doctors or medicine. The apparatus with which these wonderful results are to be obtained consist mainly of an electrical chair and carpet. The pre-eminent medical electrician does not deal in electropathic belts, in which he does not place any faith, or things of such a low order, but like his congener, Harness, he is not unmindful of the poor, for the carpet has been specially designed to meet the wants of the working classes and those patients whose circumstances are not such as to enable them to come under the Professor's treatment, or to defray the cost of the electric chair. We have already alluded to a lecture given by Moross at St. James's Hall, on June 12th last, and we had imagined that the cool reception which his pretensions received at the hands of a certain section of the daily press would have kept him in comparative obscurity, but the *genus* medical electrician is irrepressible, and so it will continue until it comes within the meshes of the law; and we really think that some Member of Parliament should be induced to bring this kind of quackery before the notice of the House.

Instead of the nuisance showing any signs of abatement it is rapidly on the increase, and this is not to be wondered at when we consider the monetary success which has attended the operations of some of the now notorious vendors of so-called medical appliances. A man need only possess assurance and audacity enough to set himself up in commodious and handsomely furnished rooms, advertise himself freely as a medical electrician, and he at once reaps a rich harvest. Could not Sir Lyon Playfair, Sir John Lubbock, Dr. Cameron, or even Mr. Labouchere take up this gross abuse of electrical science and bring all rank impostors to task? Many a matter is continually cropping up in Parliament which does not affect the country in anything like such a degree as do these wholesale raids upon the pockets of the public at large. Mr. De Watteville might try to exert his influence through the medium of the medical Press upon his fellow practitioners, and we should be glad to aid in any movement of a practical nature to rid the community of such pests as certain of these so-called medical electricians.

Omnia mutantur, nos et mutamur in illis. This maxim is very applicable just now to our contemporary *Industries*, the London editor of which, our esteemed friend Mr. Gisbert Kapp, has, we regret to say, resigned his position, and has this week severed his connection with that journal. Those persons who have watched the progress of our contemporary since its commencement a little over three years ago, must have noticed the excellent manner in which the electrical department especially has been conducted under the able editorship of Mr. Kapp. This gentleman always tried to be first in the field in noticing new inventions, &c., and if by chance a contemporary anticipated his intended notice, he would decline to have anything to do in the matter, a policy which is not, however, always beneficial to the interests of readers of technical papers. Mr. Kapp has brought *Industries* to a high standard of efficiency, and the sole reason of his resigning is, we are informed, due to the fact of some unpleasantness having arisen with the proprietary. We believe Mr. Kapp intends to start in business as an electrical engineer, and we wish him every success in his old sphere. His successor in electrical matters will be Mr. J. Swinburne, who, we imagine, will now dissociate himself from all business matters which might influence his editorial opinion.

A SHORT time ago we announced that steps were shortly to be taken with a view to the Houses of Parliament being lighted throughout by electricity, and that probably tenders would be asked for the lighting. A portion of the Houses is already, and has been for some time, electrically illuminated, and it is surprising that this has not become general. Then, again, there are the various Government establishments, the majority of which are not yet supplied with electric lights. The post offices, generally speaking, are badly served, and one characteristic of them is that the desks allotted to the public for writing telegrams, filling up money and postal orders, &c., are exceedingly poorly lighted. Whether this is another example of red tapeism or not we cannot say, but it is high time that a change took place. In this connection the English Government might take a leaf out of the book of the Indian Government, which is about to introduce electric lighting in the Viceregal residence in Calcutta, and also in that of the Lieutenant-Governor. Several companies are competing for the contract, but the tenders sent in show a higher cost than was expected. One of the difficulties met with is the fact that the light is only required a few months in every year, and this has led to the suggestion that accumulators should be employed. This, however, is impossible, owing to there being no central station in the immediate neighbourhood or district. A direct system of transmission is generally advocated, and will doubtless be carried into effect. Everybody in the Indian towns seem to favour the introduction of the electric light, but unless the schemes are worked out in an economical manner very little good will result.

IT has been accepted as an acknowledged fact that lead-covered cables, when placed underground in creosoted wooden troughs, undergo a rapid deterioration of the lead sheathing owing to the metal being converted into a carbonate, but closer research tends to show that this destruction need not necessarily take place. Close observation of creosoted conduits and lead-covered cables, laid at various times since 1884, apparently prove that the destructive agent usually present in freshly creosoted wood disappears almost entirely after a few years. A cable was laid upwards of two years ago in a conduit constructed in 1884, and at this date there is but very slight trace of action on its surface, while part of the same cable laid in an 1888 conduit shows considerable scale of carbonate of lead after one year's exposure. Parts of the same cable placed in other conduits about a year after their construction show but little damage. One cable laid in 1885 is only slightly affected, and it is not anticipated that any further deterioration will take place. Some experiments, to test the effect of time and ventilation on creosoted wood, were carried out by placing cables covered with an alloy of tin and lead in boxes made of creosoted wood, one box made of wood creosoted more than two years back, and another more recently impregnated. These boxes were sealed up and opened after a lapse of three months. The samples in the old wood box were barely touched, while the samples in the newer one were thickly covered on the sides and top with what is chemically known as phenolate. Either phenol, a volatile, gas, or acetic acid in combination with carbonic acid gas will attack lead and reduce it to a carbonate. If no acetic acid is present in the wood, and the phenol be evaporated by some means or another, there should be no more damage done to lead cables in creosoted troughs than if they were run in conduits of other materials; but means should be taken to freely ventilate the troughs, not only to protect the cables, but also to guard against accumulations of explosive gas. Under these conditions plain lead sheathing would prove as efficient as that made of the tin alloy, the durability of which latter covering can hardly be accepted as assured.

SEVERAL enterprising American Tramway Companies, not content with having altered their systems from horse to cable traction, are about to contract for the conversion of the cable system into one worked by electricity.

FROM Chattanooga comes the interesting account of a neat little bit of Company promotion. The patentee of an electric light system erected a small installation there, and then sold his plant, with his State rights, to a local company for $8,000. Having obtained his money he left town, so did the money, and so apparently did the electric light, for that has been out ever since. The shareholders are anxiously awaiting the promoter's return.

A MAN-OF-WAR of the present day may be anything but a thing of beauty, but it has its countervailing advantage in being naturally protected from lightning strokes. Far different was it in olden days. In 50 years over 200 ships of the British Navy were struck by lightning, while from 1810 to 1815 some 48 vessels were more or less damaged. In one squadron of 13 ships, blockading, or cruising off the French Mediterranean coast, five were struck during one night with a heavy loss to their crews. Many casualties occurred in the Navy through the explosion of powder magazines.

A DR. WATSON in the last century proposed to protect British warships by a copper conductor, and he was requested by the then First Lord of the Admiralty to devise a suitable method for so doing. His lightning conductor consisted of links of copper made into a chain, which was made fast to a strong rope and attached to an iron rod on the royal truck, whence it was taken to the sea below. This conductor was supplied packed in a box, to be applied when it was deemed necessary. There was some difficulty in erecting this chain, and very often by the time it was fixed the storm was over. It was never popular, and in consequence it was seldom used. It was not without danger to fix the conductor in working order, several sailors in an American man-of-war having been killed while in the performance of their duty of taking the chain aloft. This mode of protection fell into disuse.

THE well-known scientist, Sir William Snow Harris, then took up the question of protecting ships from lightning, and by every means in his power urged on the authorities to provide permanent conductors for our warships. He was successful in his endeavours, and our navy has experienced comparatively little damage from lightning since then.

APART from the modern vessels being protected by their construction, or by special provisions for the purpose, it would seem that lightning does not play as destructive a part as it did 40 or 50 years ago, as even those ships unprovided with conductors have suffered less damage than a smaller number of ships experienced formerly. Not that modern vessels are exempt, but they seem to be struck in a manner which causes fewer fatal accidents, and in some cases, even, the effects of a lightning flash have borne so little trace of their origin that they have been credited to the wilful act of someone on board.

THE recent adoption by the Post Office of an arrangement by which telephonic communication in certain districts will be available to those of the general public who are not subscribers to a telephonic exchange, will, if generally extended, but hasten the acquisition of the whole telephonic system by the State. That this change is bound to come sooner or later there can, we think, be but little doubt. The adoption of the sixpenny rate, forced as it was on the Postal Department regardless of the extra expense to the country which it involved, has no doubt to some extent retarded the buying up of the telephonic companies' interests, as there is always a tendency for the Government to wriggle out of any scheme which involves extra expense, unless public opinion, by a division in Parliament, forces their hands. The public will, we believe, welcome a telephonic system worked and controlled by the Postal Telegraph Department, as it means a good service and good apparatus; the high rates of subscription, if at the present scale, would, however, decidedly be grumbled at, and probably pressure would have to be brought to bear to make some material reduction in this respect. The acquisition by the State of the telephonic system in London would eventually mean the abolition of the overhouse wires, an improvement which would be hailed by those of an æsthetic turn of mind, with great pleasure, even if the absence of interruption from fires, gales, and snowstorms, is not taken into consideration.

IT seems time that something practical was done with reference to the electrical unit question; we hear a great deal of talk and the suggestion of a large number of new units, chiefly mechanical, which it cannot honestly be said any one has felt the want of, but good solid work in the form of practically determining the value of the units which are in constant use has been only done spasmodically by a number of isolated individuals. What is being done in the matter of the proposed Standardising laboratory? We should also like to know when the report of the Institute of Electrical Engineers' committee on electrical nomenclature is likely to be issued, although in face of the fact that the whole matter seems to be forgotten by those who are most interested, it would seem as if the report might be postponed indefinitely without much loss to the community.

INDUCTION AND OTHER THINGS.

MACAULAY used to be inspired by the book he was reviewing, and write an original essay on the same subject. In one case, for instance, he began by saying he was not going to mention the book under review in the rest of the article. We propose to write this essay in Macaulay's best style, but Dr. Fleming's recent book[*] is far too important a work to be treated in at all an off-hand manner. We will, however, digress into matters which are not in the book, but are merely suggested by it.

Dr. Fleming's work, though not otherwise suggestive of Macaulay's style, is far too comprehensive for its title. It is really an encyclopædia article on "induction" of the most thorough and complete kind, and might have been meant for insertion in a very large electrical lexicon.

The conventional ideas about electricity and electrical induction are undergoing such rapid changes just now, that it is very difficult for people with little time at their disposal, or small mathematical attainments, to follow them. Dr. Fleming's first volume therefore appears just at the right time.

There is confusion in the use of the terms "lines of force" and "lines of induction" in many books. We would suggest that the terms should be kept quite distinct. In statics, if the attraction between two exceedingly small bodies is to be calculated, you think of one of them, and then imagine straight lines drawn from it in all directions. To find its attraction on the second body, you find how many lines per square centimetre there are at the second body due to the first body, and multiply by the mass of the second. If preferred, the second body can be considered to develop a star of lines, and the number per square centimetre so produced by it at the first body, multiplied by its mass again gives the mutual attraction. The force here varies as the number of lines per sq. cm., so these lines may well be called lines of force. These lines of force are straight. Suppose, however, we consider the bodies to radiate their lines at the same time; the lines will intersect one another all through space. If these sets of lines are now replaced by lines representing their components, we get a system of curved lines, which are crowded together where they enter or come out of the bodies. To get the force acting on one of the bodies it is necessary to take the surface integral of the component of the square of the number of lines per sq. cm. over it. These are therefore not lines of force but of induction. In the example taken, if the lines are both taken as positive, the force will be repulsion; so one set of lines of induction must be taken as going into the body, not out of it; as if that body was negatively charged while the other is positive. We thus get a clear distinction between lines of force and lines of induction. We might, perhaps, consider lines of force to belong to volume integrals and action at a distance, and lines of induction to surface integrals and action through a medium; but it is unnecessary to go into this here. Lines of magnetic induction are thus not lines of force at all, though they are frequently so-called, and to find the force due to them a surface integral of their squares has to be taken. To find the force on a unit pole in a unit field, the unit field is sometimes taken as being produced by a unit pole at unit distance, but sometimes it is put into a field induced by a current, or by a magnet with two poles; that is to say, it is supposed to be put into a field of unit induction, and it is not supposed to interfere with the direction or distribution of the induction. Here we have a mixture of the line of force and the line of induction methods; we take a volume integral of the product of the induction and magnetic density of the loose pole. To be consistent, we might imagine the induction disturbed by the insertion of the loose pole, and then take the surface integral of the square to get the force. It is not for a moment pretended that such a method would be mathematically convenient, but that it might be more consistent physically. Take, now, the case of a conductor carrying a current inserted in a magnetic field. To get the force by the mixed method, a volume integral of the product of the current density, and the component of the induction at right angles to the direction of the current turned through a right angle is taken. To get the same result by a surface integral, the field may be taken as disturbed by the current, and, as the force is at right angles to the direction of the induction, such curves as those of equal potential might be taken. We do not bring forward these suggestions as practical, or particularly valuable, but as showing how a confusion of lines of force and lines of induction might be avoided. If the notion of loose poles, acting on each other at a distance by means of lines of force, instead of through a medium by lines of induction, is discarded, we eliminate the idea of magnetic moment, and of magnetisation; and it might be of great advantage to get rid of magnetisation altogether. What is magnetisation? Nobody exactly knows. Take an electro-magnet. It is treated as if it were not a solid lump, but were made up of a number of minute magnets with space between them. The magnetisation of each little magnet is due to the direct action at a distance of every element of current, and of all the rest of the particles taken one end at a time. It is just as difficult to conceive the little magnet as the large one, but it is very common to try to avoid such difficulties by referring them to ultimate particles, or to little imaginary things instead of big real ones. Of course, the particles are supposed to be uniformly magnetised. There is also supposed to be induction in the spaces due to the action of the current elements and the ends, and the two together make up the total induction. Sometimes the particles are considered already magnetised, and the magnetising, or magnetic force of the exciting current is supposed to turn them against friction of some sort. Instead of magnetisable particles we may take the Ampère-Weber theory. Suppose the particles are not magnetisable, but are perfect conductors in a belt round their equators. If an exciting current is started it will induce surface currents in these particles, and they will try to arrange themselves at right angles to the exciting current. The action is like that of the disc in Dr. Fleming's alternating current galvanometer—which, by the way, he has omitted from his book—or of the closed armature coil of a Tesla motor. If the particles cannot turn freely the body is thus diamagnetic. If perfectly free to turn the body is neither diamagnetic nor paramagnetic, like a gas. If the particles have currents initially they will try to arrange themselves parallel to the exciting current, like the moving coil of a dynamometer. If the initial currents are small the particles will first try to arrange themselves parallel, but the current will be decreased by the exciting current, and it may finally be reversed, when they will try to move back again.

The great beauty of the molecular current theory of magnetisation is that it cuts its own throat, if we may use such a vulgar expression in its connection without disrespect to so recondite a phenomenon. There is then no magnetisation at any point in the whole electro-magnet; and we have only to deal with magnetic force, or, if we prefer it, induction, and may discard notions of magnetisation altogether. In addition to magnetisation being merely an idea, we have the difficulty that in some bodies the susceptibility is zero, so that you may apply as much magnetic force as desired without magnetising it at all. But some bodies have a negative susceptibility. They begin by not being magnetised at all; and when you apply magnetic force they get still less magnetised. This is an idea of great beauty. On the other hand, if you think of induction and permeability these difficulties are avoided.

Magnetisation appears therefore to be either an abstraction adopted for mathematical convenience, but having no physical meaning, or a quantity chosen to fit some speculations on ultimate constitutions of matter, the most promising of which entirely discards it. Data for providing for speculations as to the nature of magnetism may as well be given in terms of magnetisation, magnetising force, and susceptibility; but for other purposes it would appear to be best to deal with induction and permeability only. The expression $\frac{1}{4\pi}\int H\,dB$ is much clearer to think about than $\int H\,dI$ for the energy lost in magnetising and demagnetising iron.

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[*] "The Alternate Current Transformer in Theory and Practice." Vol. I. The *Electrician* Printing and Publishing Company, Limited. 1889.

Dr. Fleming devotes a whole chapter to the subject of electro-magnetic induction, and puts it about as clearly as it could be put. There is a slip on page 55, where "magnetising force" is used instead of its line integral. Dr. Fleming seems to be partially converted to the use of the idea of magnetic resistance. We would not mind magnetic reluctance much, but magnetic resistance always seems a confusion of ideas. We will not go into that, however.

Dr. Fleming not only writes very fully, as well as succinctly, but also gives copious references. These demand considerable labour on an author's part, but are very valuable to a reader. Maxwell said that when one wanted to read up anything it was best to buy a foreign text-book, which would provide a bibliography of the subject in its reference notes. We have, of course, the Royal Society catalogue of papers, but the German Government indexes the scientific and technical periodical literature of all countries, which is very useful.

We would not recommend Dr. Fleming's experiment of lifting the brushes of even a small shunt dynamo with the hands. It not only spoils the commutator, but may easily give a serious shock if done sharply. Quite a little 100 volt machine will make one feel ill for an hour or two. A large one generally punctures its field insulation, and short-circuits on to its series wire. Lifting the brushes before a machine is stopped is also a common way of burning up hot wire voltmeters in commerce. The alternating people in the States might retaliate on the direct current by making their criminals open the shunt of a big dynamo through their bodies.

(*To be continued.*)

OVERHEAD WIRES AT EXETER.

AT last week's meeting of the Exeter Town Council there was a somewhat animated discussion on the subject of overhead wires. At the outset a letter was read from Mr. Michelmore, the secretary of the Exeter Electric Light Company, who stated that his attention had been drawn to a discussion which took place about a fortnight previously, when there appeared to have been a great deal of misapprehension on the part of many of the members of the Council as to the erection of posts and wires. The stays to the posts were merely temporary, and would be withdrawn as soon as the work was completed. With regard to the cross pieces on the top the Company had the permission of the Council to erect them. It was the intention of the Company, as soon as they were able, to place all their wires underground in the central and most populous parts of the city. He thought they would be in a position to do so about three years hence.

The **TOWN CLERK** presented a report on the regulations drawn up by the Board of Trade with reference to electric lighting, and which applied to the Metropolis. These regulations provided that aerial wires should be carried at a height of not less than 20 feet, and across a street not less than 30 feet. They also stipulated that no wires should be placed within 6 feet of any building, except where brought into the building for the purpose of illumination. The Town Clerk added that permission had only been given to the Exeter Company to erect the poles subject to notice at any time to remove them within twelve months. The Government had adopted the underground plan for their telegraph wires, and most of the successful electric light companies at home and abroad had adopted the same course.

Mr. W. H. **DUNN**, in accordance to notice, proposed, "That notice be given to the Exeter Electric Light Company to determine the permission given them to erect posts in the public streets in connection with the electric light at the earliest possible date." He reminded them that it was impossible to go through the streets of Exeter without being struck by the very great inconvenience which must arise from the posts and wires being erected as at present. In the very face of a unsatisfactory report presented by the Borough Surveyor the Council had authorised the Company to erect their posts and wires. The Streets Committee passed a resolution against according the permission. He found among the majority of sixteen in favour of granting the permission the name of the chairman of the company himself. That was an illegal act, and there were penalties attaching to such an act. There was a clause of the Act of Parliament which stipulated that no gentleman should take any part in, or vote on any matter in which he was personally and pecuniarily interested. The streets and pavements of Taunton were double the width of those at Exeter, and the houses were not so high. Therefore the danger and inconvenience of the posts and wires were not felt there to the same extent as they would be at Exeter. Being so near to the houses the wires, in case of fire, would prevent the prompt raising of the fire escape, and when scaffolding had to be erected for painting or repairs they would be sadly in the way. Moreover, the wires constituted a deadly danger. He was told of a fireman, who came across some of these wires and cut at them, being struck dead immediately. (Laughter.) Is it death you laugh at? asked Mr. Dunn.

MR. WILLIAMS: No, but your idea. (Hear, hear and laughter.)

Mr. **DUNN** said he received the information from one of their own officers, and he would rather accept his opinion than his friend's laugh. The fact was an ugly one. He was sorry to put the company to any expense, and the council must not suppose that he was opposed to them. He had done all he could to prevent Exeter being charged excessively for lighting. Look at the thousands which the council had spent in improving the streets, and yet they gave the company permission to erect posts and wires in order that they might pay a penny in the pound extra dividend. These wires and posts, as they were at present, constituted a great source of danger. He was willing to alter his resolution so as to read in effect that, provided the company would undertake, at the expiration of three years, to place the wires in the chief streets underground, the council would submit to the inconvenience for the intervening period of time.

The **TOWN CLERK** said it would not alter the legal position of the council. Permission had been given in certain terms, and those terms must be rigidly adhered to. If anything, the resolution would place them in a worse position, for at present the posts were removable at a twelve months' notice, whereas if Mr. Dunn modified his resolution in agreement with the letter received from the secretary of the company, they would not be able to get the posts removed in less than three years.

The **MAYOR** ruled that Mr. Dunn could not modify a resolution of which he had given notice.

Mr. **DUNN** then decided to move the resolution as it stood upon the agenda paper.

Mr. **HALL** seconded. He did not see that if the motion were carried it would in any way interfere with the company. Twelve months' notice would be given them, and all he hoped was that no great fire might occur in the meantime. If so, the wires would retard the speedy use of the fire escape, which would be a most serious matter, as most of the houses were built of wood at Exeter. A few minutes in such cases would be a matter of life or death to the inmates. The gas company had to lay their mains underground, and why should not the electric light company? By granting permission the council had sanctioned a state of things which might jeopardise the lives of the citizens.

Mr. **BLACKBURN** said it had been notorious that Exeter was 50 years behind the times in respect of almost every material improvement. The gas supply of Exeter was as bad as it possibly could be. Their guilded chambers were damaged by its fumes, and they all suffered in health from its noxious vapours. He knew there were gentlemen on the Aldermanic bench connected with the Exeter Electric Light Company who would not do anything contrary to honour. He ridiculed Mr. Dunn's motion. Why did he not bring forward his objections before the electric light company had proceeded so far with the work?

Mr. **TOWNSEND** vigorously defended the electric light company, and said if they had not been accorded permission by the Council to erect their posts and wires, Exeter would not have had the electric light at all. It was done to break down the gas company's monopoly, and the sooner that end was attained the better it would be for the ratepayers. The underground system was impracticable, as the earth attracted the electricity.

Mr. **TREMLETT** followed in the same strain.

Mr. **WILSON** quoted from Mr. Preece's recent paper read at the meeting of the British Association at Newcastle, to prove that the dangers in case of fire had been greatly exaggerated. He ridiculed the notion of a man being killed on touching an electric wire. Shocks which were supposed to be fatal had been taken by Colonel Armstrong, who felt better afterwards. (Laughter.) With regard to the case cited by Mr. Dunn of a man being killed at Brighton, it appeared that the current was turned off two hours before the man was killed. (Laughter.) Gas, with its sulphurous fumes, had destroyed its thousands in Exeter, and destroyed its hundred of thousands in explosions; and here was a man who talked about the dangers of electricity. (Laughter.)

Mr. **ORCHARD** supported the electric light movement.

Mr. **ROBERTS** (Chairman of the Fire Committee) said that he did not consider that the wires would be in the way in case of fire, for they possessed a telescopic escape.

On a division, 11 voted for and 25 against the resolution, which was therefore lost.

LIGHTNING CONDUCTORS.

By S. ALFRED VARLEY.

(*Continued from page* 150.)

NATURE OF ELECTRICITY.

THE most characteristic feature of electricity may be said to be its intimate relation to matter, and the absolute control it has over matter.

It seems very probable indeed electricity is concerned with the internal structure, and the atomic constitution of the molecules of which matter is built up, and as it is impossible to add to, or separate electricity from matter, we are almost driven to the conclusion that electricity should be considered as much an attribute of matter as mental power, for example, is an attribute of the higher forms of animal life.

There is a universality in the mode of action, not to say a vitality about electricity, which no other force possesses. By virtue of its being the highest attribute of matter, it would seem to be capable of guiding and controlling all the forces influencing matter. With its assistance heat, light, magnetism, mechanical force and chemical action can be produced when, and we may say, almost, where we choose; there is no distance within the limits of our terrestrial system too great for it to connect men together, and enable them to converse with facility, and when applied to such purpose it appeals not to one sense only, but to all of them; the blind can converse through the sense of hearing, the deaf and dumb through the sense of sight, and those afflicted with the loss both of sight and hearing can communicate through the sense of touch.

The relationship of electricity to matter seems to resemble in no small degree the relationship which subsists between vitality and mental power, for vitality (which must be regarded as an advance on electricity) is guided and controlled by mental force, much in the same way as matter is controlled by electricity, and it would seem probable the mind holds communion with its material system through the medium of matter's highest attribute—electricity.

The only dual forces associated with inorganic matter are electricity and its companion, magnetism, and the dual mode of action of these two forces may be considered to distinguish them as an advance on other forces, for we find a principle of duality associated also with vitality. We speak, nevertheless, of vitality as a single principle, and are probably correct in doing so. It may be also that notwithstanding electrical phenomena are essentially dual, electricity is itself (as Franklin believed, and as the tendency of modern research would seem to suggest) a single and not a dual entity.

Electricity is not only inseparable from matter, but it comports itself similarly to matter in respect to energy; to set up electrical motion involves the association of energy with the electricity of the matter composing the circuit much in the same way as the setting matter in motion involves the association of energy with matter, the only difference between electrical motion and material motion seems to be that in the latter case the mass of matter with its combined forces are all moved together, whereas electrical motion would appear to be the movement of an internal force associated with the structure of matter. Conductors permit of this internal motion to a considerable degree, without the cohesive force that builds the atoms into molecules and binds them together being overcome, but possibly all conduction is more or less a breaking down and a regrouping of the ultimate atoms of matter. The fact that matter can be absolutely broken down by electrical pressure is evidence that electric motion subjects a conductor to more or less stress.

The writer considers we are as fairly entitled to speak of electrical motion in a closed circuit as we do of material motion through space, for motion may be defined as the transmission of energy, and it is equally a transmission of energy whether it be electrical or material motion.

A closed electric circuit comports itself in respect to matter outside it, as a molecule or as a mass of matter at rest, there may be a radiation of force from it as a whole, but there is no motion inside it in respect to outer matter any more than there is motion of matter in reference to absolute space. There is inside the circuit motion in relation to the atoms which constitute it, as there is, similarly, motion of matter relatively to other matter in our solar system. An electric circuit may therefore be considered to be a system within a system.

What electricity itself is, we shall probably never know, but it must be considered an entity of some kind, and if to enable the mind to grasp what appears to be immaterial, we assume electricity to have a concrete shape, then electricity will be found to comport itself very much like matter.

To put matter into motion it must be brought under the influence of energy, and in like manner electricity has to be associated with energy to set up electrical motion, the chief, if not the only, difference being that the vehicle in the one case is matter and in the other that it is electricity.

Electricity must certainly be considered to be an advance upon matter; that being so, matter and electricity cannot in a strict sense of the term be exactly comparable—for example, matter is under the control of forces which have no influence on electricity; material and electrical motion also differ in the fact that matter moves through what is termed space, whereas electricity moves through matter; moreover, the electricity set in motion forms part of the conductor itself, and is concerned in its structure, and therefore it has to be set free before it can be moved.*

The energy which sets up the electrical motion acts probably from the centres of the molecules; but with respect to the conductor as a whole, energy may be regarded as acting laterally as well as progressively.

The quantity of energy necessary to unlock and put the electricity into a condition of motion is as the square of the electricity moved; but as the matter in a conductor, and also the electricity associated with it, are definite amounts, the electricity which can be set in motion is limited, and if the electricity be brought under the influence of an undue amount of pressure the molecules themselves become broken down and their structure altogether destroyed, the energy now escapes by radiation in the form of heat, the atoms then come together, and new molecules or groups of molecules are produced.

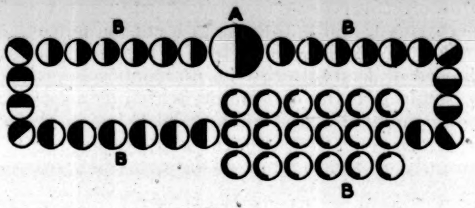

Fig. 5.

The illustration, fig. 5, will help to make clearer a conception of the general nature of conduction. The larger circle, A, represents an accumulator or a voltaic cell containing stored up energy in a condition of unstable equilibrium, and needing only the establishment of a circuit to enable it to set up electrical motion.

The smaller circles, B, indicate a metallic path through which the circuit is closed; part of this path is represented as being composed of three sets of molecules side by side, and the rest of the path is represented as composed of a single row of molecules.

The unshaded portion of the circle, A, may be assumed to represent the + electricity of the positive pole of the cell, and the unshaded half of the circle the − electricity of the negative pole.

The voltaic cell, A, which may consist of a zinc and platina plate whose lower ends are immersed and separated by a mixture of acid and water, contains stored up energy in the form of chemical energy, and the superior affinity of zinc over that of platina for oxygen sets up and determines the direction of the electric motion, when it occurs.

The affinity that exists between oxygen and zinc causes the oxygen of the water molecules to endeavour to break away from their associated hydrogen, and so enable new molecules to be constructed by a combination of zinc and oxygen; the breaking down existing molecules and the formation of new ones necessitates a separation and rearrangement of the electricity or electricities concerned in all molecular structures, and such separation and rearrangement involves electrical motion.

Now, when oxygen combines with zinc in a voltaic cell, or when a combination of oxygen occurs directly with zinc, carbon, hydrogen, or other substances, energy becomes unlocked. How, or why, we know not. Electricity cannot be added to or taken from matter, and the formation of a closed circuit by connecting the two poles of a voltaic cell by a conductor permits a separation and rearrangement of the electricity or electricities concerned in the atomic structure of the molecules, without adding to or taking from the electricity associated with matter.

The molecular structures which constitute a voltaic couple are in a condition of unstable equilibrium, because the mutual affinities of zinc and oxygen for one another loosen the bond which unite the hydrogen and oxygen of the water molecules, and there must be a divorce between the oxygen and hydrogen to enable a union between the zinc and oxygen to be consummated. A specific relationship exists between + electricity and hydrogen and − electricity and oxygen, and when molecules of oxygen and hydrogen are broken down and fresh combinations formed, the oxygen and hydrogen in the act of separation take with them their respective electricities. The effect of the strong affinity of zinc for oxygen is to drive the + electricity of the voltaic cell to the one side of the molecules which compose it, and the − electricity to the other side of the molecules, as indicated by the light and shaded portions of the circles in fig. 5; consequently a state of electric polarisation is induced throughout the elements of the voltaic couple, and the two poles become statically charged to a small degree through the dielectric air. Bridging the air space that separates the two poles of the voltaic cell by a conductor, enables the water molecules to be broken down one after the other, and new molecules of zinc and oxygen to be formed, a transference of the electricity concerned in the molecular structure of the conductor corresponding with the number of water molecules broken down occurring throughout the conductor, the zinc and platina plates, as well as the liquid constituents of the voltaic couple, the + electricity of the positive pole of the voltaic couple, A, combines with an equivalent amount of − electricity of the molecule immediately contiguous to it on the left, and the balance is restored by the − pole receiving a corresponding quantity of + electricity from the molecule contiguous to it, a similar interchange occurring also throughout the whole of the molecules composing the chain, and therefore the + electricity travels from molecule to molecule throughout the whole system in one direction, and the − electricity in the other.

Granting that the above theory of electric conduction, which is associated with the names of Franklin and Faraday, be correct, it follows the passage of an electric impulse through a conductor, whatever may be its length, must be instantaneous unless it be retained by statical charge, and theoretically it can never be wholly so. The *act* of an electric discharge can be, however (and, in practice, always is), more or less delayed, both by the induction which occurs between conductors and neighbouring matter, and also by the magnetic inertia which all conductors oppose, and which involves a storage of energy inside the conductor; but, nevertheless, an electrical thrill must pass throughout the whole of the circuit at one and the same moment, and therefore unless our physicists are prepared to throw over the Franklin-Faraday theory altogether, there cannot be a special rate at which electricity travels, such as "Modern Views of Electricity" would appear to involve.

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* There is probably very little real difference after all in the motion of matter through space and the motion of electricity through conducting matter. Electricity moving through a metallic conductor of infinite sectional area, would be not unlike matter moving through what is termed space. The relative position of the planets in our solar system as well as their orbits are as rigidly determined as if space were solid; and if a planetary mass could be propelled at a high rate of velocity from the outside into the space embraced by our solar system, resistance would be opposed similar to that encountered by a rifle bullet if fired into a block of wood or if it were fired into a stiff magnetic field; lines of force have to be cut by the projected mass, and this would give rise to electric currents and heat both in the projected mass and also in all the members of the solar system. Cutting through magnetic lines of force, that is to say, forcing a passage through magnetic space is a pushing back of the magnetic poles, as can be very easily demonstrated; and when meteoric bodies outside our solar system come under the influence of terrestrial or planetary gravity, heat must be developed in them not only from friction of the atmosphere but from their having to cut through lines of force to enter and become parts of our solar system. There is an experiment the writer has had a long time in his note book and which he would be glad to see tried, viz., the effect of firing from a rifle a copper bullet through a long and strong magnetic field; if it passed fairly through the centre he anticipates great resistance would be encountered and a corresponding amount of heat developed; but if the bullet enters the field above or below the central line, he thinks it will probably be deflected much in the same way as bullets ricochet from the surface of water. He further believes that if a glass bullet were propelled *at a sufficiently high* velocity through a magnetic field, resistance would be encountered.

The rate at which the molecules of water are broken down and molecules of zinc formed is directly as the electrical pressure developed in the voltaic couple, and inversely as the resistance of the circuit; the energy unlocked during the act of oxidation is as the weight of zinc converted into oxide, and therefore the amount of zinc consumed in the cells of a galvanic battery is a measure of the energy which has been liberated, and which becomes associated with the electricity put into motion.

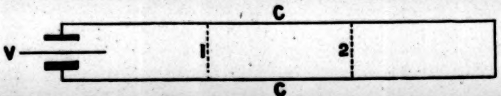


FIG. 6.

Let V, fig. 6, represent a voltaic cell closed through the loop conductor, C, and let it be assumed the resistance of the cell is so small as to be negligible, and that the resistance of C is relatively so great that it may be taken as representing the whole resistance of the circuit. Assume the length of C to be 3, that its resistance = 3, and that 1 ampère per hour is developed through it by the voltaic cell with a consumption of one unit of zinc per hour. Reduce the length of the conducting path, C, one-third by connecting the two sides of the loop at the dotted line 2, this will bring down the resistance from 3 to 2, and it will be found that the current will be increased to 1½ ampères per hour, and zinc will be converted into oxide in the cell at the rate of 1½ units per hour. Now connect the two sides of the loop at the dotted line 1, this will reduce the length of the electrical path to one-third of its original length and its resistance will = 1; the current developed will now be increased to 3 ampères per hour, and zinc will be consumed at the rate of three units per hour.

In the three examples just given it will be observed the electricity, the energy, and the consumption of zinc corresponded, that the zinc consumed in the cell increased in the same ratio as the resistance was decreased. From this it will be seen that the rate at which zinc becomes oxidised in a voltaic cell is determined solely by the resistance the circuit opposes, and were it possible to construct a voltaic couple whose resistance was infinitely small a completion of the circuit would produce a violent explosion similar to what occurs when the energy stored up in gunpowder is unlocked by contact with highly heated matter.

Increasing the electrical pressure will increase the current much in the same way as reducing the resistance of the circuit, and three cells arranged in series will force the same quantity of electricity through a resistance of three as one cell will through a resistance of one, and, therefore, so far as a current is concerned, increasing electrical pressure is equivalent to reducing resistance.

As the rate at which oxidation of zinc proceeds in the voltaic cell increases in the same ratio as the resistance becomes decreased, and as increasing the electrical power has a similar effect to reducing resistance, the conditions which regulate the rate of the oxidation are the same with an electrical pressure of three and a resistance of three, as with an electrical pressure of one and a resistance of one, and, consequently, when three cells are joined through a resistance of three the consumption of zinc in *each* of the three cells proceeds at the same rate as that which occurs when one cell is connected through a resistance of one. In the one case, through a resistance of one, three ampères are obtained from the consumption of three units of zinc, and in the other example through a resistance of three; the development of three ampères of current involves a consumption of nine units of zinc. The energy liberated in the cells is as the amount of zinc oxidised, and, therefore, it follows that the three ampères of current through a resistance of three are associated with nine units of energy, in other words the energy is as the square of the current.

In fig. 5, where a conductor of considerable resistance is indicated as closed through a voltaic couple whose resistance is assumed to be so small as to be negligible, the conductor is represented as composed partly of three rows of molecules side by side and partly of a single row of molecules. Now, if it be assumed that there is passing through the circuit a current = 3 ampères associated with energy = 9, the energy becomes dissipated into space by radiation from the conductor in the form of heat, the heat developed is a measure of the work performed in unlocking and setting into motion the electricity combined with the conductor; the heat so produced at any one portion of the conductor is as the resistance of that particular part compared with other parts. Now, where the conductor is composed of three rows of molecules there is, length for length, three times as much conducting matter, and consequently, three times less resistance in the molecules composing this portion of the conductor, therefore one third of the work only has to be performed, and it follows as a consequence that only one third of the heat developed where the conductor is composed of a single row of molecules, is produced in that portion of the conductor which consists of three rows of molecules, and as the heat is also divided over three times as much matter the temperature is raised one ninth only of that developed in the other parts of the conductor.

Much of what appears immediately above will be regarded by readers of the journal as elementary, the excuse for its introduction is the writer's anxiety to give, as far as in him lies to do, a complete analysis of his conception of the nature of electricity. What he has attempted in words is usually expressed, and can be more concisely stated, mathematically, but scientific truths expressed in mathematical language seem to the writer to suffer from being lifeless and wanting body and soul, and they are consequently not always *usefully* grasped by mathematicians themselves. Further, the writer desires to emphasise that electricity is closely allied to matter, and that a study of matter, which is more within our grasp than the immaterial, is likely to be more fruitful of sound progress than the indulging in pure hypothesis, which our mathematical physicists seem to delight so much in doing.

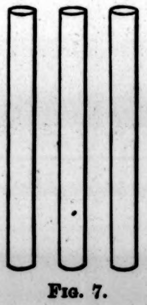


FIG. 7.

Fig. 7 represents three pipes of equal diameter and length, and if it be assumed that a pressure of one pound on the inch will force a gallon through one pipe in a minute, the same pressure applied to the three, will force through three gallons per minute; but if it be desired to force three gallons per minute through only one pipe, a pressure of nine pounds on the inch will be required, and this is strictly in harmony with what is known of the motion of electricity. Matter, however, possesses weight, which electricity does not, and therefore the energy associated with matter in motion is as the square of the velocity multiplied by the weight of the body moved. The chief, if not the only difference between matter and electricity as vehicles of energy, consists in the fact that electricity has no weight and theoretically it is therefore in every way superior to matter as an agent for transmitting energy.

(*To be concluded.*)

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 258.)

VI.—ARMATURES IN PRACTICE—(*continued*).

THE method of winding the armature introduced by Gramme was dealt with in our last article, and we have now to consider the form of winding introduced by Siemens some years later. Referring to fig. 119, it will be remembered that the two sections connected in parallel to the split ring commutator were wound round the ring inside and outside, each section thus enveloping the cross section of one side of the core. But it is evident that each may envelop the whole of the cross section by winding round the ring and across the ends, as in fig. 126. In the engraving there is shown only one turn of wire for each section, to simplify matters. The section, E, starts from the commutator plate, B, laps once round the armature, and returns to the plate, C, while the section, D, starts from C, envelopes the armature once, and returns to plate B. A comparison of figs. 119 and 126 will make the difference in the manner of winding quite clear.

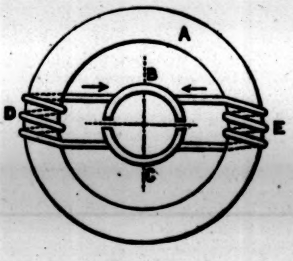


FIG. 119.

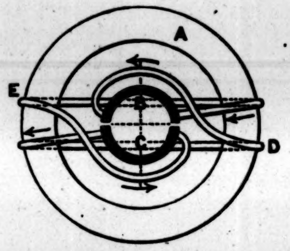


FIG. 126.

If the ring were wound over with a large number of sections lying close together, and split ring commutators were employed, there would be for each pair of sections one commutator, and on following out the results, as we did for the Gramme winding, we should find that, as a consequence of connecting all these separate commutators in series, the winding would be virtually resolved into an endless helix. This arrangement of commutators and brushes can be simplified as formerly, by substituting for the split ring commutators a parallel bar commutator, having connected to each bar the end of one section and the beginning of the next. When so simplified, the winding is known as the Siemens, or drum winding; an armature thus connected, and having 12 sections, being shown in fig. 127. There is one convolution of wire for each section, and therefore 24 external conductors in all. The dotted lines show the conductors crossing over at the back end of the armature, and the winding is easily traced out with a little patience. Starting from the right hand commutator bar, the current flows down A (away from the reader) and up B, the end of the section being then joined to the adjacent commutator bar. In the next section it flows down C and up D to the next commutator bar, then from E to F, G to H, J to K, L to N, joining the left hand commutator bar at O. The direction of the current in the other half of the winding can be similarly traced. The winding thus forms an endless coil, the current flowing through it in two parallels, as in that of Gramme.

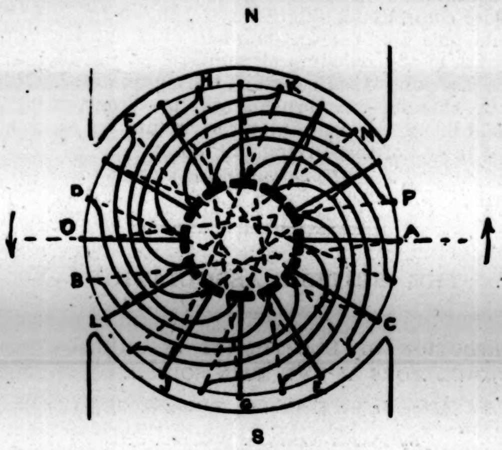


FIG. 127.

It will be observed that with the Siemens winding there must be at least two external conductors for each communicator bar, while in that of Gramme there may be only one. The E.M.F. in volts is given as before by the equation

$$E = \frac{N\,s\,W}{10^8}$$

where N is the total flux of lines of force through the armature, S the number of revolutions per second and W the number of exterior conductors.

If the armature is to be placed in a four-pole field the winding must be modified, the sections, instead of embracing half the circumference of the cores, being made to embrace only about one-fourth. An armature so wound in 12 sections, and having 24 external conductors, is shown in fig. 128, the dotted lines showing the crossings of the wires at the back end of the armature. Following the winding from the top commutator bar the current traverses sections A B, C D, &c., in succession, the end of one section and the beginning of the next being joined to successive bars. This gives a continuous winding, and there are four positions of

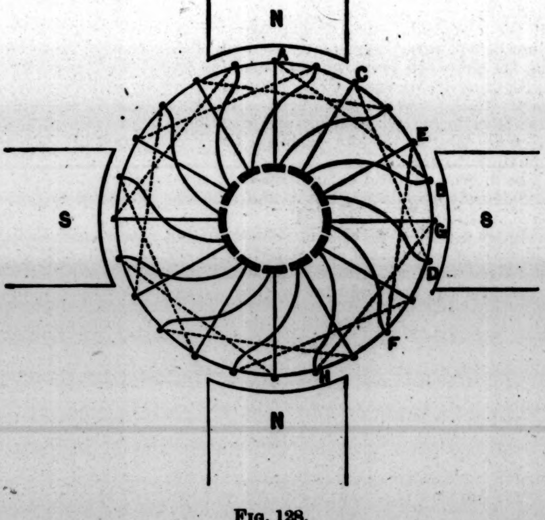


FIG. 128.

collection corresponding to the four positions in which the sections are inactive. The collection may be effected as in the case of the Gramme ring, either by placing a brush at each of these four positions and connecting opposite brushes together, or by placing two brushes on the commutator 90° apart and cross connecting the opposite commutator segments. If the drum is to run in a six-pole field the sections will each embrace about one-sixth of the armature circumference, and there will be six positions of collection on the commutator. There may be, therefore, six brushes employed, or two at an angle of 60° if the commutator segments are cross connected in sets of three lying 120° apart.

(*To be continued.*)

THE BRITISH ASSOCIATION.

DISTRIBUTION OF ELECTRICITY IN CHELSEA WITH ACCUMULATORS AS THE MAIN SOURCE OF SUPPLY.

(*Read before Section G, September*, 1889.)

By MAJOR-GENERAL WEBBER, C.B.

ACCUMULATION of electricity is the first necessity to those who study the conditions of its supply to consumers living in a thickly peopled district, and has been so since the notion of distribution to an inhabited area from a centre of generation has taken a practical form. In face of the many cases in which distribution has been undertaken without accumulation, this may be regarded as a bold statement. But I can only say that I have not met one who, having adopted it, does not candidly admit that the advantages of the presence of means of accumulation are undeniable.

The financial question has governed the advance of the industry, and the scattered nature of the first demands for a supply of electricity has, without doubt, led to the adoption of high-pressure distribution when every other consideration would have appeared to suggest that all first attempts should have been made at low pressure.

The insulation afforded by the use of aerial conductors has led to partial success. If the distribution had had to be carried out by underground mains from the first, the deterrent effects of the experience that would then have had to be gained might have led to different procedure, and even the financial aspect of the question might have gone through different phases.

Some will assert that the industry in this country could not have made a start at all, in the face of cheap lighting gas, if it had not been pioneered by means of economical conductors, however temporary, and without attempting to accumulate. But, after all, it was only a question of cost, and it is certain that had the capital been forthcoming in 1886, it would have been as easy to have obtained success with the system I am about to describe as now. All the essential means now at our disposal, except matters of minor detail, were then equally at hand. This is proved by the fact that the proposals prepared and made in 1886, immediately after the Chelsea Provisional Order was approved by Parliament, are similar to those which have been carried out in 1889. It was as clear then that accumulation and distribution underground was the true solution of the problem for a comparatively densely populated district.

The district of Chelsea was selected, not as the wealthiest or most densely populated, but because it was destined then, and since then, and for some time to come, to be one in which the dwellings are in a process of reconstruction. It was in 1886 as evident as it is now that the impediments in the way of getting old houses wired is a serious hindrance to the rapid spread of the demand for current, and that this impediment is minimised under that condition.

In the interval many of us have been fascinated by the high-pressure systems. I think myself fortunate that, I may say, accident prevented me attaching myself to any scheme dependent on that condition, together with alternating currents, for domestic supply. The temptation was rather strong for one reason at least —that is, that some capital was forthcoming to promote the latter, while very little could be got together to carry out the former plan. Although it is not sound, the engineer sometimes *does* surrender his better judgment when money leads.

The Chelsea system may be described in the following terms :—

Accumulation of the main supply from a generating station in storage stations, situated at suitable distances from one another, combined with the following :—

(*a*) Charging the accumulators at high pressure, and discharging for distribution at low pressure, and effecting the changes necessary to the same by special automatic arrangements placed in each storage station.

(*b*) Supplementing the main supply by means of continuous-current transformers.

(*c*) Distributing by means of mains laid down in a network.

(*d*) Maintaining a constant pressure by means of the introduction into the discharge circuit of counter E.M.F. cells, and by means of feeding points judiciously placed intermediate between the storage stations.

(*e*) The use of underground conductors throughout, laid so that the cables can be drawn in and out, and renewed or repaired whenever necessary, without disturbing the ground.

It has been remarked that one of the causes of interference with the spread of the use of electric light is the outlay entailed by the necessity to introduce conductors and fittings for distribution and consumption within the house.

Members of a society called the Dynamicables will remember a paper on this subject, read a few years ago by Mr. Crompton, when he expressed a hope that the cost of such work might be brought down to 15s., without including the lamps and their fittings, for each point where the light is required.

The fact that this figure has rarely been realised, and more often doubled, is not, however, the chief impediment. It has been suggested that the undertakers might carry out the work on a deferred payment system, but this would meet only a limited number of cases. The main cause of impediment at present is the condition of the situation as regards landlord and tenant, by which there is no inducement to the former to do more for his tenant than his lease obliges him to do, and by which there is no compensation to an outgoing tenant for outlay on *bonâ fide* improvements.

The fitting up of houses for gas consumption has now, by competition, been brought down to about 7s. for each point where a burner has to be fixed above a certain minimum number of points.

Except under Government departments, I have rarely encountered any form of specification for such work. I have never yet heard of gas engineers being called in to advise on or pass work for the distribution and consumption of gas inside buildings, beyond questions of meterage and regulation of pressure.

The consequence is that the proportion of gas which from one cause or another escapes unburnt, and enters into combination with the air we breathe, is very considerable in proportion with the gas we actually use to give us light, varying from 1 or 2 to 7 or 8 per cent., some due to defects in pipes, more to defective burners.

For economy, the same work in connection with electric lighting is rapidly tending to fall into a similar condition, and were it not for the practical necessity to take precautions to protect buildings from fire risk, and the public from injury to person, which has given rise to Fire Insurance and Board of Trade rules, the consumers of electric current ere long would find themselves in a worse condition than if they stuck to gas as an illuminant, for reasons in connection with leakage which are evident to all my hearers without any description.

In Chelsea we have from the first endeavoured to counteract this evil by

First. Holding aloof from all appearance of having any pecuniary interest in the work of fitting up houses in the area of supply.

Second. Supplying to the inhabitants, either free of cost or for a small fee, a copy of our standard specification for such work. This form is compiled so that it can be used under varying conditions when filled in by a competent engineer. A sample of it is attached to this communication.

The necessity for care and precaution in this respect, and the consequence of a little more trouble and expenditure to the public than has hitherto been given to the subject of lighting, is, however, well repaid by the advantages to health and comfort by adopting electricity as an illuminant.

This is the sole lever with which electric light undertakers have to work in face of

1. Competition with cheaper illuminants, which in the case of mineral oils are one-third to one-fourth the price of electricity, light for light, both as regards first and annual cost.

2. Indifference to the question of health so long as the danger is not very apparent, only being very slowly counteracted by the spread of knowledge.

3. Rules and regulations which everyone acknowledges to be salutary, but which must hamper the industry at first, particularly so as the rival illuminants are not subject to anything of a similar kind.

The apostles of electricity as an illuminant have, however, no fear that sooner or later it must triumph, and that the poor as well as the rich will eventually enjoy its advantages ; and that those who have given labour and attention of the most exceptional nature to produce perfection will eventually reap their reward.

Leaving this branch of the subject of consumption, it should be stated, *en route*, that the meters in use in Chelsea are those of Aron, Chamberlain and Hookham, and of the Brush Company.

The first, which is used in this country under a royalty from Messrs. Ayrton and Perry, and which is at present in a large majority, has undergone considerable modification and improvement in construction lately, with the result of greatly simplifying its action. The meter as now employed has no starting gear as formerly, to which objection had been found to exist.

The meter is compact, being about 2 feet 5 inches long by 15 inches wide and 8 inches deep. It is constructed of two sets of clockwork, the deviations of which are to be indicated, mounted side by side in the same frame with a differential counter placed between the two sets of clockwork. The clockwork is driven by a spring. The differential counter consists of two crown wheels, having at the same time a cylindrical gear opposite each other. Between the crown wheels a planet wheel is arranged gearing with both the crown wheels, and is made so as to turn at the same time round its own centre, and so as to roll along the cylindrical gear of the crown wheels, and it is balanced by a counterweight.

The vibrations of the pendulum of one of the sets of clockwork is either accelerated or slackened by the influence of a coil through which the whole of the supply current passes; the pendulum has a permanent magnet or armature attached to its end, and is so arranged to swing immediately over the centre of the coil. The clockwork being synchronised, there is no movement of the indices on the dials when no electric current is passing, although the clockwork is running continuously. The clockwork runs for six weeks, but we find it advisable to wind them once every month to ensure them from accidental running down before their time, and thus stopping their use for registering. They are easily fixed in position by a workman. It is only necessary that care should be taken to set the pendulums so that they hang immediately over the setting pin placed for the purpose. The man then winds the meter, starts the pendulums swinging, and the meter is then ready for work and for the purpose of recording where the electric supply is started.

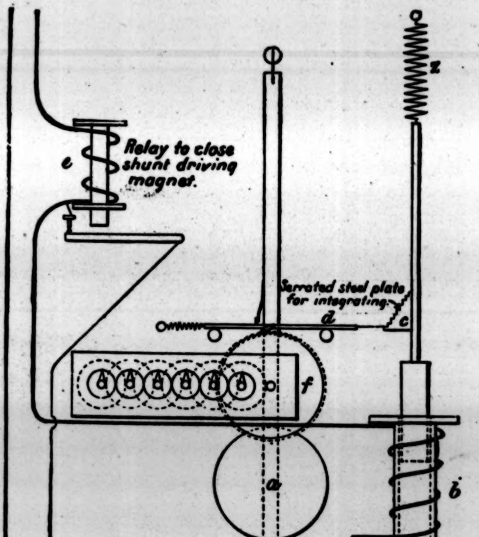
These meters have given most satisfactory results during the six months we have had them in use. The meter registers in ampère-hours—*i.e.*, each unit registered by the index dial has to be multiplied by a constant supplied with each instrument.

For the convenience of customers a multiplier is supplied by us with each meter card, and instructions printed stating that the amount registered by the indices at any time multiplied by the multiplier given on the card enables them to ascertain in Board of Trade units the consumption of current.

The meter of Messrs. Chamberlain and Hookham has been so thoroughly described this year by Mr. Hookham before the Institution of Electrical Engineers that I need not give any of its details. Our experience of its working is at present very limited.

The Brush Company's meter may be described as follows:—

The meter consists of (*a*) an electrically driven pendulum, suspended over an electromagnet (a_1), but slightly at one side of it. Near the pendulum is placed, vertically, a solenoid (*b*) in circuit with one of the conductors to the lamps; the core is carried by a light rod attached to a spiral spring suspended from above. To the side of the rod towards the pendulum is fixed, in the plane of oscillation, a notched integrating plate (*c*). As the core is drawn down by the current passing through the solenoid, or lifted up again by the spring, the notched plate is also raised and lowered. An horizontal arm (*d*), resting on two rollers, travels backwards and forwards with the movement of the pendulum, but the distance travelled, or amplitude, is controlled by the notched plate, being greatest when the core is drawn down so that the horizontal arm travels as far as the uppermost notch, and smallest when the core is elevated so that the arm is stopped by the notch on the edge of the widest part of the plate. The arm carries a small catch, which, when it travels to the left, drawn thither by the spiral spring at that end, pushes round the last and lowest wheel of the counting gear (*f*). For instance, when the arm moves through the shortest distance the wheel is pushed round only one notch.



The smallest movement may be regulated to occur when one-third of an ampère is passing through the solenoid, and thus accurate metering is ensured by the construction of the parts being such that for each sway of the pendulum the last wheel of the gear is always advanced through an angle exactly proportional to the current flowing at the moment.

The electromagnet (a_1) used for driving the pendulum is on a shunt from the supply main, the circuit of which is closed and opened by a relay which comes into action with the smallest current that the meter is required to measure.

I have described the main features of this apparatus only, but there are other minor ones; for instance, a contact-making device worked by the pendulum for the purpose of properly timing the impulses given to the electro-magnet (a_1), with which I will not occupy the meeting.

A marked feature in the system of distribution by continuous current at low pressure is the absence of the transformer from the premises of customers, and the small space required in the house for the meters and cut-outs. Although the space required for a transformer is not theoretically large, in practice it is found that its installation is a more serious cause of expenditure and interference with structure than the advocates of its use lead us to suppose. In very few houses is to be found a chamber suitable to receive a transformer of ordinary size. In 1887 I inspected one of the first installations under the system, namely, at Lucerne, by Ganz & Co. These I found the transformers in cupboards, and heating so as to colour the surrounding woodwork. The insurance companies in England would not have permitted them to remain a day in such a place. It is wrong to suggest that the installation of a transformer does not entail an expenditure much in excess of its actual cost. This condition affects materially the comparison between the first cost of rival systems.

We now come to the work outside the customers' premises, and I am able to show you a diagram illustrative of this part of the distribution.

The area comprises portions of the parishes of Chelsea and Kensington. Its superficies contain about 867,000 square yards, or about 1/3·5 of a square mile. This area, divided into storage areas, in each of which a storage station is, or being, placed, allows to each such sub-area a space represented by a square of 415 yards a side.

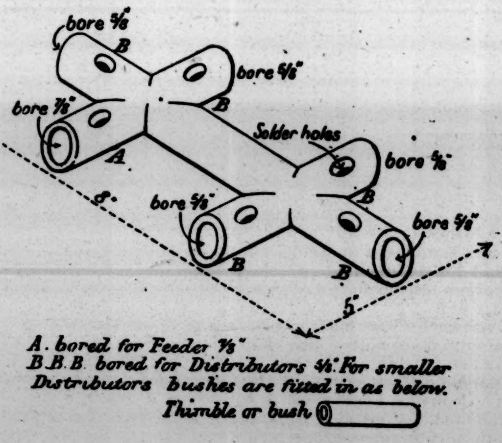
The generating station is marked, and in the same building is placed a storage station. The other storage stations are marked, and of these there are five in all. The points to which feeders are taken are each marked +, with letters to most of them. Each storage station itself is also a feeding or E.M.F. point. At present, the feeders vary in section between 61/12 and 37/13, according to the length and the current it is estimated they will be called on to conduct.

The distributing mains, which are laid so as to supply the houses in every street prescribed by the Act as compulsory, sometimes in front and in some places at the back, connect all the E.M.F. or feeding points, and vary in sections between 37/13 and 19/16.

The pilot wires from the storage stations to the generating stations, and from the E.M.F. points to the regulators in the storage stations, are of small section, and have their separate "ways" in the conduits or cases.

All the "ways" can receive cables of larger dimensions, so that the section, when necessary, can be increased. And, besides, in each line of conduits spare "ways" are provided for future use. Up to the present time, about 10,575 yards of cable have been drawn in and put to use, besides some thousands of yards of pilot wires. By the end of this year these figures will be increased more than half as much again.

The joints in the E.M.F. boxes, between the feeders and the distributing systems, are made by soldering the cables to a copper jointing piece, made as shown in the diagrams.

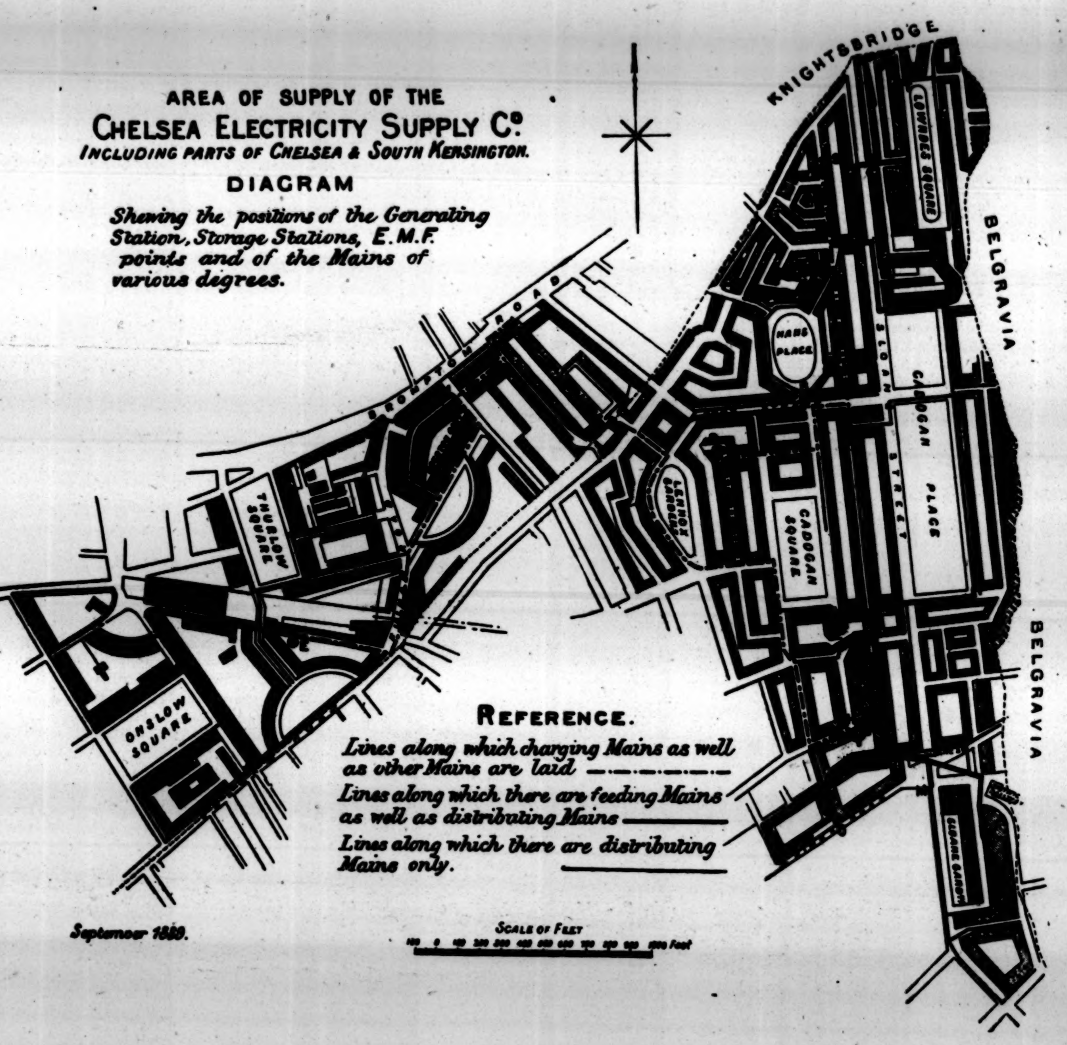


All cables, after being drawn in and before being jointed, must show an infinity insulation resistance test before being passed. The test is made at a pressure of 100 volts. In many instances, after joining up sections of the network, and testing them together, including joints of house services, the disconnected ends sealed the same result has been obtained.

The question of the cost of the mains and house connections is one which forms a most important factor in the undertaking.

After careful consideration of the subject from all aspects, the use of bare copper conductors was discarded. With the permission of the War Office, experiments had been made by me at Pimlico with bare copper conductors so long ago as 1884. In making the tests I had the kind assistance of Prof. Ayrton, F.R.S. The conductors were made of uncovered copper wire cables, I think 19/12. They laid in notches made in insulite saddles, seated in cast iron troughing 6 feet long, jointed end to end, and having covers also carefully jointed; the cables were free of all approach to contact with the surrounding iron, and all the joints of the iron casing were watertight, or believed to be so. Tests were made with a 50-ampère current at an E.M.F. of 80 volts at intervals of some months after the wire was laid underground, and it was tested under the two conditions of having the intervals around the cables left vacant, and filled in with paraffin wax.

The results led to the complete abandonment of the plan, and of the patent which had been taken out for it. There is a strong resemblance between it and the mains which are being now laid down in the district in London known as the St. James's. For the sake of the industry, in which so many are interested, I trust that those responsible for that work will meet with greater success than I did.


AREA OF SUPPLY OF THE
CHELSEA ELECTRICITY SUPPLY Co.
INCLUDING PARTS OF CHELSEA & SOUTH KENSINGTON.
DIAGRAM
Shewing the positions of the Generating Station, Storage Stations, E.M.F. points and of the Mains of various degrees.
KNIGHTSBRIDGE
BELGRAVIA
BELGRAVIA
BROMPTON ROAD
LOWNDES SQUARE
HANS PLACE
SLOAN STREET
CADOGAN PLACE
CADOGAN SQUARE
LENNOX GARDENS
THURLOW SQUARE
ONSLOW SQUARE
REFERENCE.
Lines along which charging Mains as well as other Mains are laid
Lines along which there are feeding Mains as well as distributing Mains
Lines along which there are distributing Mains only.
September 1889.
SCALE OF FEET
100 0 100 200 300 400 500 600 700 800 900 1000 Feet

Experiments were made in 1886 and 1887 with the view to obtain some form of conduit which afforded a separate "way" for each insulated flexible cable; and so that the old and well-known *drawing in and out* system of the Electric and International Telegraph Company, founded on an experience of many years, might be followed. A metal tube for each cable was too costly. The bundle of cables in one iron pipe would prevent the possibility of drawing in and out. The material of bitumen concrete, which could be moulded to any form, presented itself, and the patent of Butler as to the mixture was followed. The Callender Bitumen Company undertook to carry out the work, and a sample line of casing and cable drawn in was laid, and was under trial during the period of one year at the Borough Road premises of the Anglo-American Brush Electric Light Corporation. Out of this has grown what has become known as the Callender-Webber system. All that was anticipated of its advantages have been more than realised in Chelsea.

Although the part of Chelsea in which operations were carried on should present the fewest difficulties to be encountered in any part of London, it was found that there was little or no local knowledge as to the size or position of the cellars of houses, and that no one could tell where the arches stood, or where the water and gas mains and services actually lay.

As the access to house service boxes must be easier if the main is in the footway than if it is in the roadway, every effort was made to keep within the edge of the kerb. But to do this in many places was found at first to be impossible, and the cases had, in several places, to be laid under the roadway. In such a position it was necessary to keep them outside the gas and water mains, and as the local authority prescribes a minimum distance of 3½ feet between these mains and the kerb, and 1½ feet between mains themselves, it followed that those for the electric light had to be 8 feet or 9 feet from the kerb.

The future inconveniences arising from this are so many that it has now been decided never to lay the "cases" anywhere under the roadways, except at crossings, unless absolutely physically impossible to do so. The material of which the "cases" are made lends itself to this, as it can be made in flat sections, with a single tier of holes, O O O, and in such a form occupies very little space in depth. The facility of bending it is also a great aid in passing obstacles.

There *have* been instances in which we have been able to get in "*casing*" in advance of the services of the gas and water companies, and in those we calculate that the cost is reduced at least 10 per cent.

The great ease with which the material of which the casing is made can be cut, simplifies the operation of inserting a house service box on the mains that have been previously laid. Only that portion of the case need be removed which contains the ways in which lie the distributing mains. The box is best formed of brick in cement, and the top of cast iron, with a waterproof cover flush with the footway.

The same manner of construction has been found best for draw-boxes, the iron tops of which are either L or T shape, also the E.M.F. boxes, where the feeders terminate. In the latter case the ordinary street manhole cast-iron top has been found to answer very well the purposes of a cover.

Practice shows that if the sides and bottoms of the box were also made of iron, a great variety of patterns would be required, as the conditions vary at every point, so that brick in cement for all these boxes is the best material.

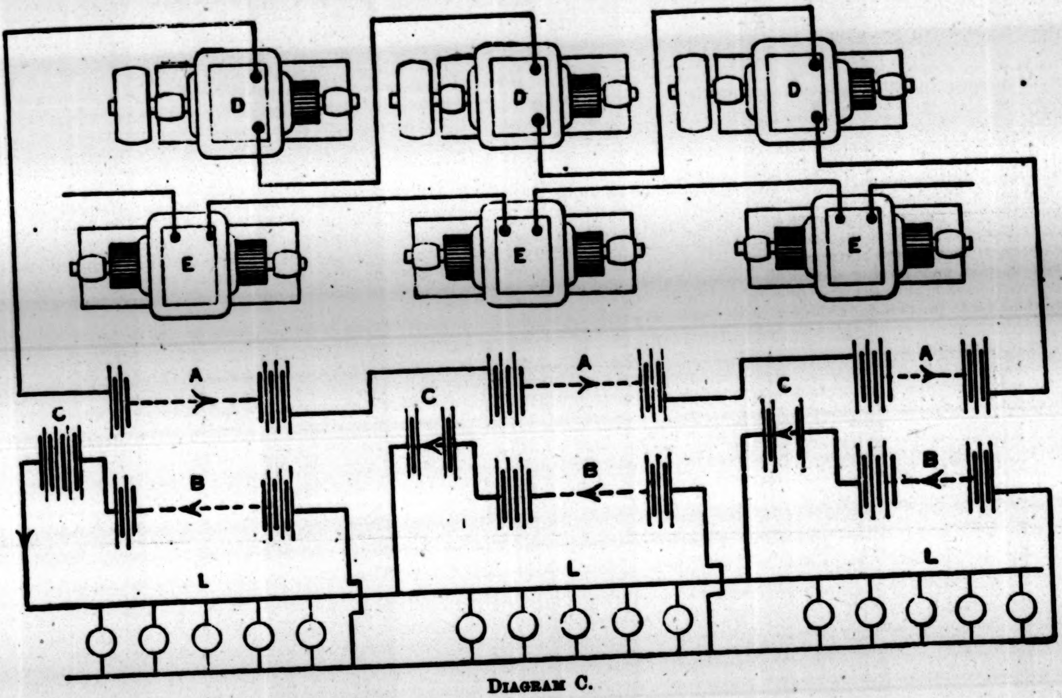


Diagram C.

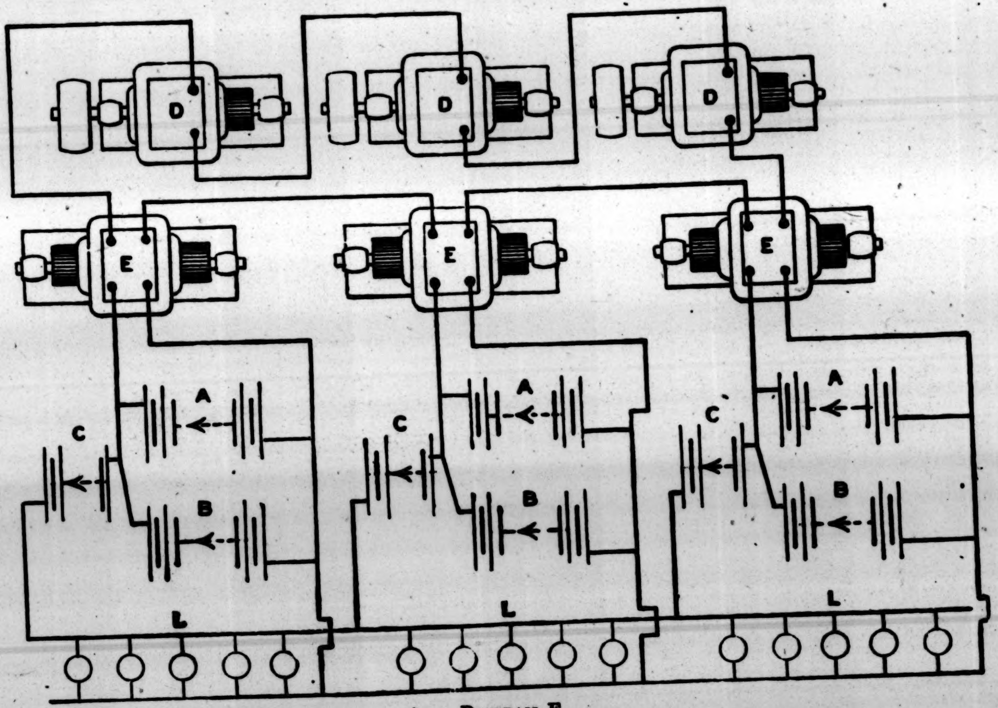


Diagram E.

A specification of the manner of conducting the work is in use, and a copy of it is attached to this communication. If care and attention is given to the simple rules for laying the casing, no difficulty is encountered with the cables. A true and smooth way is provided for each, so much so that in rare cases of need, from one cause or another, no difficulty has been found in pushing through from box to box one of those screw-jointed rods used by sewer men or chimney sweeps.

It will be gathered from the features of the system I have referred to that considerable economy in excavation can be secured by its adoption, in actual cost of the "ways" for the cables, totally avoiding the need for special castings for bends, and also in all the operations of branching-off and jointings. In comparison with the bare copper systems, the saving in towns in the cost of removing the soil to make space for the conduits is very considerable. Of the durability of the material, resistance to strains, and conditions of temperature, so far the proofs have been very satisfactory. But, as I have already stated, its foremost advantage is that it enables us to comply with the fundamental conditions of successful maintenance by permitting of the easy and rapid removal of faulty sections of cable, and the renewal of the same. Under such circumstances, with low-pressure distribution, a high standard of insulation resistance may be dispensed with, and a further saving in outlay effected. For let it be remembered that failures of the insulation of underground distributors of electricity will not occur by the gradual deterioration of the dielectric throughout its length, but by the existence of exceptional causes for its decay at isolated and unexpected points.

Although the substance of which the Callender-Webber casing is made is dielectric, yet no reliance is placed on it even as an assistant to the insulation.

The slight porosity of the material, and the impossibility of making an absolutely watertight joint at every point where the lengths are united, at present precludes the idea of complete exclusion of moisture.

It will be seen that this system lends itself to the manner of distribution already described by bringing within the range of practical expenditure the provision of the necessary number of "ways" for charging, feeding, and distributing mains, all of which along the same route may be lying contiguous to one another. The reference to it forms part of the description leading up to an examination of the basis of the system of distribution, in which accumulation constitutes the chief source of supply, and not a mere auxiliary. In such a system the generating station is even subordinate to the storage stations.

Given an area, and having determined what may be called (1) the active demand, and (2) the possible ultimate demand, and having decided to provide for the first, with the power to meet the second at some future date, the first thing is to lay it out in storage districts, always subject to the power of securing sites, and next, to fix the positions of the points to which feeders should be carried. This would be a difficult thing were it not for the elasticity afforded by the network system, and by the power of varying the section of copper in the mains, which is simplified by the use of "ways."

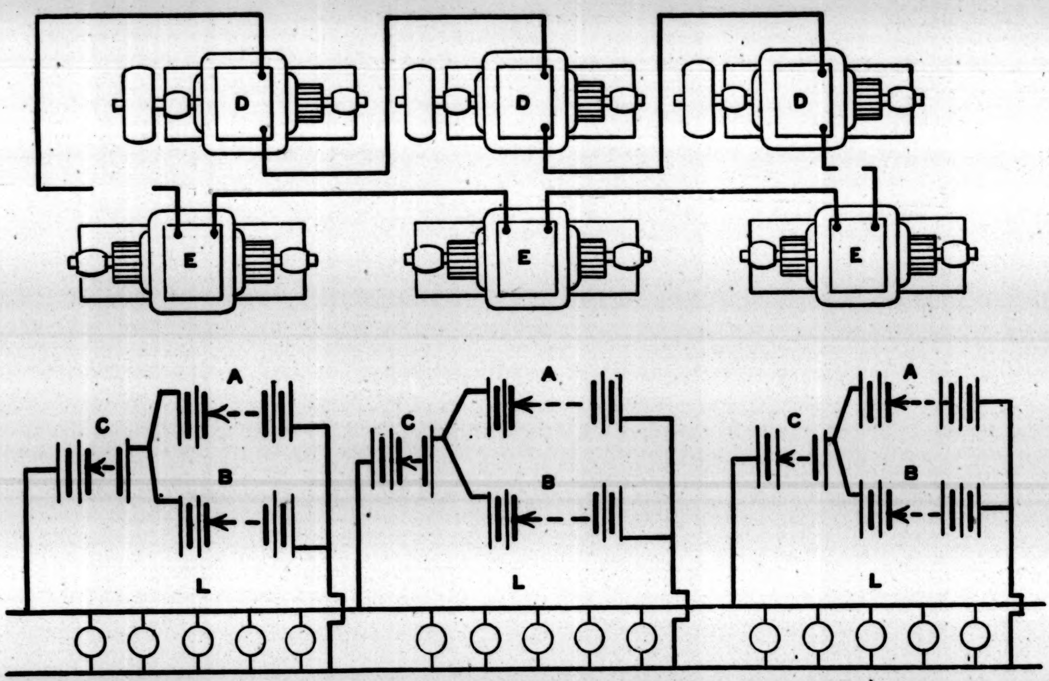


DIAGRAM D.

Our estimate in Chelsea to meet the "active demand" has been to establish one storage station to each 210 shops or residences, and to provide capacity for 27 30-watt lamps being in use at one time in one-third, or 70 of these. The distribution being at a pressure of 100 volts in the distributing mains, or 106 to 108 volts in the feeders at the station, a discharge of 600 ampères to give 530 effective at the lamps, allows an ample margin, and this is afforded by the two half batteries in each storage station discharging at the same time. Each half battery consists of four sets of 54 L 31 1888 type E.P.S. cells, or a total of 432 cells. On exceptional occasions, one of these stations may be required to discharge at the rate of 800 ampères, and will do so without injury to the cells. Although 1,890 lamps are estimated for, the capacity of the station is for a normal of 2,000 lamps, and, as has been stated, for an exceptional maximum of 2,500.

The possible ultimate demand is a thing that I believe no one at present can estimate. Of course, any of us may make the statement that every dwelling *must* take the electric light, and that it *must* come, and it is easy to sneer at any scheme which does not now provide for such an end; but from the actual experience I have had, it is clear to me that the question is still rather obscure, and that end still far off.

Meantime the Chelsea system provides for an increased capacity of 50 per cent. on the normal of 2,000 lamps—*i.e.*, up to 3,000 lamps—by the use at each storage station of a continuous current transformer which will be put to work and yield its whole output during part of the time of maximum discharge, namely, between 6 and 9 p.m.

To those who put capital into the undertaking of electric lighting it will be of interest to know that the calculations made on the basis of one-third of the houses requiring the light in five such areas as have been mentioned, and in the proportion named, show an excellent return on the investment. I only allude casually to this point, as the financial calculations of the subject do not enter into the scope of a communication to the Association.

I now arrive at the part of my subject when it is necessary to refer to the installation of the *storage stations*, and to state that, beyond a reference to the capacity of the generating and charging unit, I do not propose to give any description of the generating station, which, by the way, I do not refer to under the usual term of *central station*, as it need not be placed in any way centrally with reference to the group of storage stations for which it is required to generate charging currents. These charging currents are given by separate engine and dynamo plants, one for each station; in the case of Chelsea 75 H.P. Willans and Robinson's well-known engines, and 37½ unit Victoria Brush dynamos, which are capable of giving a current of 75 ampères at 500 volts.

The diagrams represent:

First, C, three of these plants in series charging one of the half batteries in each of three storage stations, the lighting being maintained by the other, or second half, battery; and the pressure in the distributing mains being regulated by cells which give a counter E.M.F.

In the second representation, C_1, the three plants are shown charging the second half batteries. Those which having been previously charging are now discharging to the distribution system. Regulation is still maintained as in the first position.

In the third position, D, there is a cessation of charging, and the two half batteries are shown to be discharging together in parallel. Regulation is maintained as before.

In the fourth position, E, continuous current transformers are supplying current to the system in parallel with both halves of the batteries.

The apparatus for effecting the various transpositions of the secondary batteries in the storage stations, and for maintaining the pressure constant in the mains, is automatic. The movable portions are worked by the energy which would otherwise be wasted in the counter E.M.F. cells, which are used for regulating the pressure in the distribution system. All the actuating portions of the apparatus require current at an E.M.F. of only four or five volts.

DESCRIPTION OF THE AUTOMATIC REGULATOR OF THE ELECTRICAL POWER STORAGE COMPANY.

(*For the letters of reference see diagram* F.)

The charging mains arriving from the generating station are divided and connected to the groups of mercury cups of two "*charging circuit relays.*" These relays, c_1, c_2, are identical in construction, and are really rocking switches, and come into action at the moment when the half batteries are just in or out of charge. Their function is to introduce into the charging circuit a carbon resistance, O, between the time that one half battery goes out and the other enters, the position of being "under charge."

The groups of four cups on the outsides of these relays are half positive and half negative, and the relative positions of the arms incline in the same direction. To pull them into those positions and maintain them there, each arm is actuated from below by two electro-magnets placed in a local circuit, to which I will refer further on.

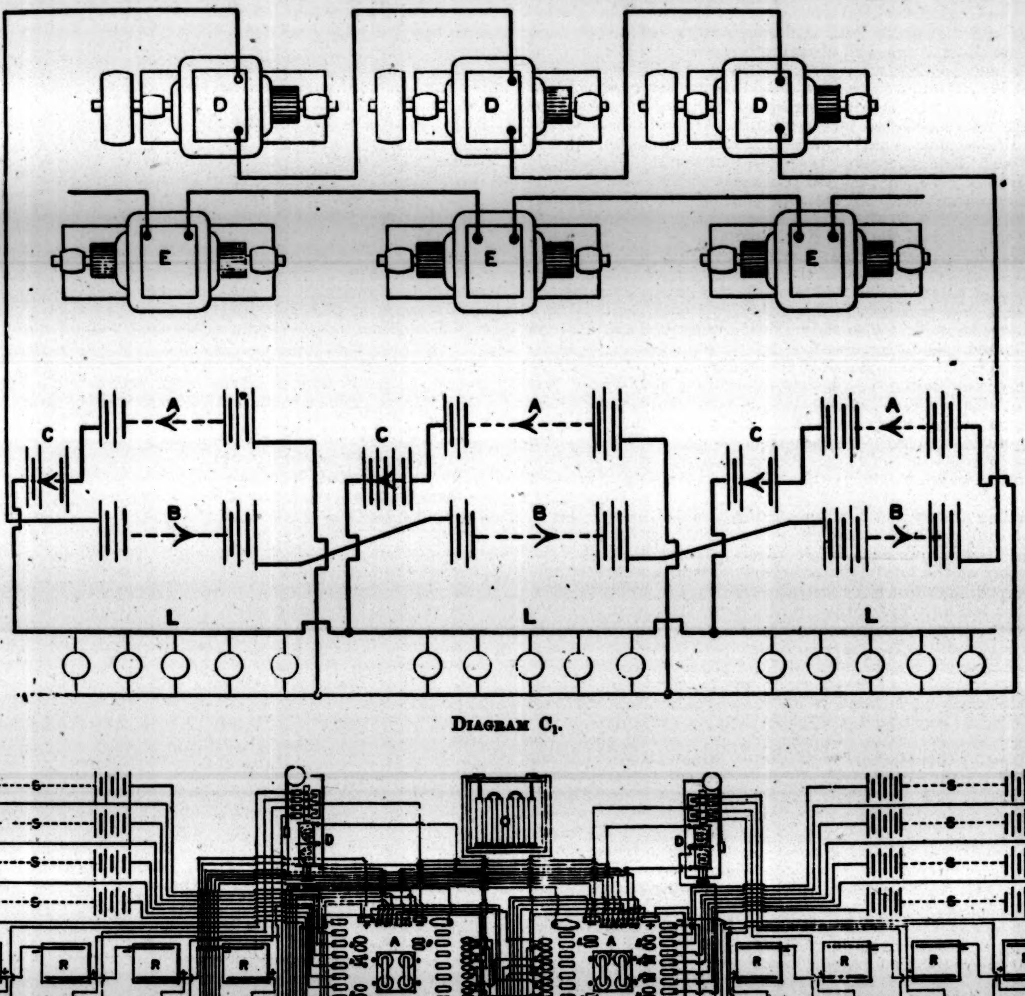


DIAGRAM C_1.

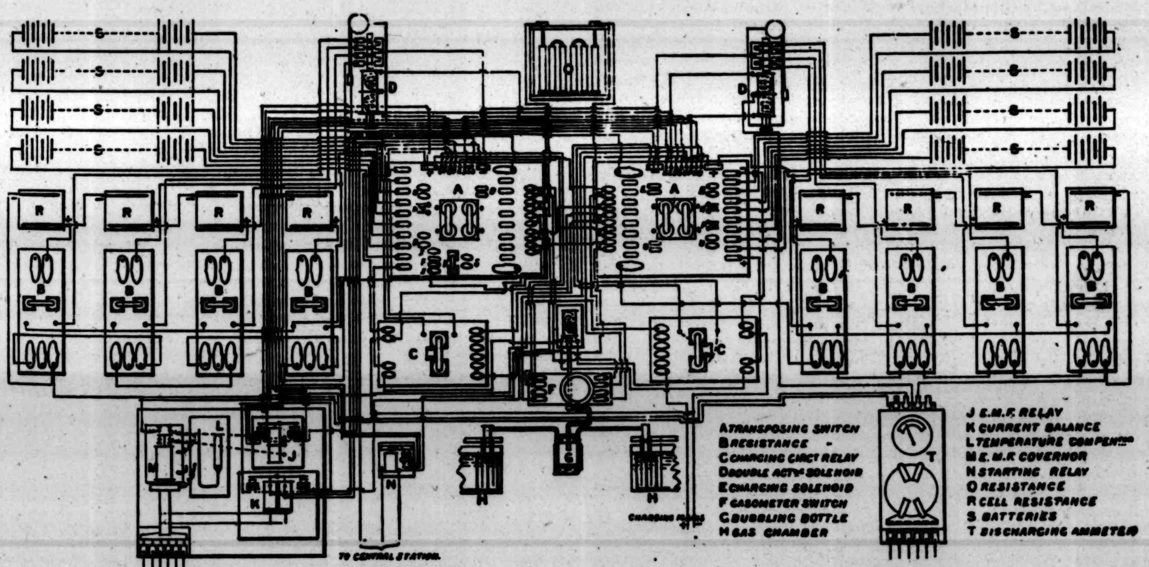


DIAGRAM F.

When the right half battery, s_1, is in charge, the right relay, c_1, is in contact on its right (as it presents itself on the diagram). The positive and negative cups are respectively in connection with corresponding cups on the outside of the right-hand *transposing switch*, A_1. The intermediate terminals are severally connected with the poles of four sets, each of 54 cells, so that these 216 cells are in circuit in series.

On the way to the right-hand *charging circuit relay*, the positive conductor has formed the coils of a *charging solenoid*, marked E. Its function is as follows: When the current is passing, the solenoid closes a valve in connection with a little gasholder, F, used to collect the hydrogen gas formed by one plate in one of the cells under charge. This cell is called a *master cell*. When no current traverses the coil of the solenoid, the valve is open, and no gas is retained in the holder.

At this point the duty of the holder, F, may be described. When the half battery is approaching full charge, gas is given off, and the valve alluded to being kept closed by the charging current, gas is retained by the holder, and commences to fill it.

The gas given off is collected first in an ebonite *gas chamber and acid trap*, marked H. The trap prevents any gas from this particular plate going anywhere else than into the gas chamber. From the *chamber* the gas passes into a bubbling bottle, G, with oil in it, which is intended to extract the moisture, and thence to the little holder. The size of the holder is calculated so as to contain just sufficient gas as will be given off by one plate after the proper state of *milkiness* of the cells has been attained. The moment it fills, a contact is made with the arm of a switch which is underneath it. This switch closes the *local circuit*, to which I have already alluded, as actuating the pulling-down magnets of the charging circuits, c_1, c_2.

To return to A, the right-hand *transposing switch*. Let it be remembered that its right-hand contacts are dipped in their cups and the left-hand contacts are elevated out of them, and the charging current can go nowhere else but through the half battery.

Meantime, discharging into the lamp system is going on from the left-hand half battery, and while this is going on the right-hand contacts of the rocking arm of the left *transposing switch* are dipped.

These contacts are so arranged and connected with the poles of the four sets of cells that they are in position to discharge in parallel. It is evident that when the positions of the rocking arms of the two transposing switches, A_1 and A_2, are reversed, the left half battery will be "in *charge*" and the right half battery discharging; and, again, that if the inner ends of the two rocking arms are dipped and they stand with opposing angles, then both half batteries are discharging, and charging has ceased.

Let us return to what takes place at the moment the arms of the switches rock into a fresh position. Underneath each of these arms, as in the case of those belonging to the charging circuit relays, C_1, C_2, are placed two electromagnets to pull them down. These electromagnets are also placed in the local circuit mentioned twice before. This operation of rocking over, so to speak, is sufficiently slow between the break and make in the mercury cups as to allow an interval of disconnection of less than half-a-minute.

During this interval the charging current does not cease, but for the time, as has been already described, is relayed through the resistance, O, by the operation of the *charging circuit relay*, C_1, the rocking arm of which, instead of moving slowly like that of the *transposing switch*, moves instantaneously.

The operation is effected in the following order and manner: As has been stated, the gasholder closes the local circuit in the pull-magnets under the elevated end of the rocking arm of the right-hand transposing switch, which commences to move slowly over, aided by a balance weight rolling in a groove on its upper side.

As the charging contacts leave the mercury other contacts under the arm break the current in the pull-down magnet of the outer end of the *rocking arm* of the *charging relay*, which being weighted, falls the other way, and effects simultaneously the introduction of resistance, O.

The rocking arm of A A_1 continues moving slowly over. It first makes the contacts, which bring the right half battery into the position of discharge in parallel, and finally makes other contacts, which, acting on the local circuit through a small rocking switch, starts the rocking arm of the *transposing switch*, A_2. Its first action is to cut the left half battery out of the lamp system, and when it completes its journey to throw the left half battery in series into the charging circuit. At the same moment, by a separate contact, it closes the local circuit which actuates the pull-down-magnet of the charging circuit relay, C_2, the effect of which is simultaneously to transfer the charging current from the resistance, O, to his next duty.

When the left half battery is charged, the next and final stage is carried out by the gasholder acting as before on the local circuit, the work of which is confined to inciting the rocking arm of the left-hand *transposing switch* to rock over, so that the second half battery goes to the assistance of its fellow.

A tell-tale wire back to the generating station from the transposing switch actuates a relay at the generating station the moment that the left-hand contacts lift out of the mercury. The current so transmitted actuates a relay which cuts off steam at the generating station.

On each side of the diagram are shown four resistance cells of the same type as those for accumulating, marked B, &c.

The duty required from them is as follows:—

1. To supply counter E.M.F. with which to regulate the pressure in the lamp system.

2. To give the required energy to actuate what has several times been referred to as the local circuit, of which there are actually two—one for each side of the apparatus.

This bring us to the consideration of what occurs in discharging from the batteries. In a system requiring a pressure of 100 volts, varying 1½ per cent. above and below, that from 54 cells is excessive, even allowing for the fall between the station and the ends of the feeders. At the same time it is necessary to have ample reserve to meet occasions of heavy discharge. To keep the pressure constant at the ends of the feeders, there must be tell-tale wires from those points to the E.M.F. governor, M, fixed on the governing board.

This apparatus is a fine wire coil in parallel with the feeders, and its function, when the E.M.F. is above or below the normal limit, to move a solenoid up and down. A lever bar connected with this completes a local circuit in a relay marked J, which, in its turn, actuates the two double-acting solenoids, D_1 and D_2, which operates simultaneously on sliding contacts in connection with *resistance* switches B_1 B_1 B_1 B_1 and B_2 B_2 B_2 B_2. These solenoids act as rheostats on the discharging circuit, by putting in or taking out the counter E.M.F. cells one at a time, and even two at a time.

The E.M.F. governor, M, is also in series, with a temperature compensator, marked L. This little apparatus keeps constant the resistance of the fine wire coil of M, by altering the length of a carbon filament, which is in circuit with the coil of M. This alteration of length, which minutely varies the resistance, is caused by the expansion and contraction of alcohol in a bent glass tube which presses on a column of mercury, into which one end of the filament is inserted.

As the bulk of the alcohol alters through temperature, the mercury is pressed up or down, and less or more of the filament is short-circuited. In order to maintain an equal discharge from each half battery, a *current balance*, marked E, is used.

This apparatus is made of two coils of large section copper, wound spirally apparently, but really cut out of a piece of copper tube.

The whole current from each half battery passes through one of these.

Should one half battery be giving current at such a rate as to run some 10 per cent. below the other, the coil acts solenoidically and completes the circuit in D_1 or D_2, whichever may be affected, and thereby, through the intervention, as before, of one of the resistance switches, B, cuts out one of the counter E.M.F. cells. The reduction of counter E.M.F. to the half battery which has been under discharging at once brings the two half batteries up to the same line.

The diagram shows at two places the connection to which the feeding mains of each kind are led. At T is placed an ammeter to measure the total discharge into the feeding mains, which can be cut in or out. At the other pole is shown a set of safety fuses; these are also used on the other pole. Of course there are many minor very important and interesting features of this beautiful invention of Mr. F. King's to which I have no space to allude.

The small relay, marked N on the drawing, has not been described, and I think it desirable to call your attention to it, not with the object of including it in the description, but in case any question may be asked about it. It completes the local circuit and causes switch A_1 to be brought into position of charge. It is actuated by a current from the generating station when the engineer is ready to start charging.

It is claimed for the system which has been under description:—

That the cost of the *generating* and *storage* plant does not exceed that of any other system. In support of this, I have a calculation before me, made by the Electric Power Storage Company for a generating and storing plant for 30,000 30-watt lamps at £45,000, or at the rate of 30s. per lamp. On the same lines, the actual cost in Chelsea for a 9,000 lamp plant has been 40s. per lamp. Under the best conditions, the generating plant itself need not exceed in indicated capacity of one-half of the maximum capacity of the system, assuming that the proportion of energy for which the consumers will pay is at least 70 per cent. of the energy produced at the terminals of the charging dynamos. The economy in space thus acquired is equivalent to the demand for space for storage.

It is also claimed that the cost of the mains is less than in any other system. And, again, it is claimed that the *working cost* must necessarily be considerably below that of any other system on account of the working of the motive plant always at its full power. To this particular feature of the system I wish to draw marked attention, together with the economical advantages in working, arising out of the complete stoppage of the machinery in motion each day for periods varying according to the time of year.

Specification of the General Conditions to be complied with in Wiring Houses for the Electric Light.

Compiled for the use of the Customers of the Chelsea Electricity Supply Company. Limited.

The contract under this specification includes all conductors commencing at the point where the supply company's work ends, and all electrical fittings which do not actually form part of the lamp fittings. It includes no lamp fittings unless otherwise specified.

1. Except where otherwise specified, the whole of the work to be carried out in accordance with the rules of the Society of Telegraph Engineers and Electricians, and the company in whose office the building is insured.

2. In every room or closet throughout the house one light will be separately controlled by a switch at the door, placed so as to be of easy access to the hand immediately the door is opened. In dressing and bed rooms this light will be suspended over the dressing table, the length of the lead to permit of the lamp fitting being about 7 feet above the door. In other rooms the light to be so controlled will be selected as being the one most likely to be in common use.

3. No lamp lead is to be less in cross section than the equivalent to a No. 18 S.W.G., and in the case of floor connections less than No. 16 S.W.G.

4. All mains and sub-mains where not carried between floor and ceiling, will be placed in approved wood casing. Where carried between floor and ceiling, they will be laid between the joists or in notches cut in the same, not less than 6 inches apart, and in no case will any pair of leads be carried between the same joists or through the same holes in partitions, &c. They will be painted throughout with asbestos paint: positive red, negative black.

5. Wherever between floor and ceiling branches leave the main, they will be laid with sufficient slack, so that the branches shall not approach nearer to the main on the opposite pole than 6 inches, the necessary cleats being attached to, and holes bored in the joists to secure that end.

6. When the lamp leads serve lamps in rooms with wainscoting or ornamental walls, where casing is not suitable, they will be led separately and by different routes to the point where the lamps are fixed, following the lines of the moulding or ornament; in such case they will be uncovered and fixed with saddles, and in no case, except where casing is used, may lamp leads approach nearer than 2 inches of each other.

7. Where there are wall hangings or tapestry the lamp leads

will be carried behind the same, if not in casing, as prescribed for between floor and ceiling.

8. In the case of plain walls lamp leads will be laid in casing from the floor upwards, or the ceiling downwards, which will be let into channels cut in the walls. Should it be desirable not to disturb the decoration or paper, they will be laid on the face of the wall, and secured by saddles. In such case the colour of the covering of the conductor should harmonise as much as possible with the colour of the walls.

9. A wooden wall block will be fixed at every point where a lamp, wall plug, switch, or cut-out are specified to be fixed under the contract; except where panelling or stone ornament already exists, when special means of attachment must be arranged for.

10. Distribution boards will be supplied and fixed if required, and will carry the following fittings besides the necessary terminals. To each circuit and sub-circuit will be furnished a switch and double pole cut-out.

11. When a distribution board is not required, a cut-out will be fixed at, or as near as possible to, the junction with each principal branch with the main.

12. Cut-outs will not be fixed at any other point in the system than those referred to in 10 and 11 except at each lamp.

13. Wall plugs, unless otherwise specified, will be fixed 2 feet 6 inches from the floor, and where there is a dado, they will be fixed above the top rail.

14. Floor plugs will make connection through a plate of insulating material laid flush with the floor, and the sockets will not be less than 3 inches apart, and must be open at the base, so that dust may fall through into a cavity beneath.

15. Unless otherwise specified, the ends of the leads to serve lamps, of which the fittings are destined to be attached to the walls, will be left, so that the future fittings can be fixed anywhere between 4 feet 6 inches and 7 feet above the floor.

16. Samples of all electrical fittings of every kind, and a drawing of the distributing boards will be submitted, and be subject to approval before being fixed.

17. Any deductions from, and additions to, the contract will be made only under instructions in writing from the superintending engineer, and no day work will be undertaken without his instructions; and no claim for such day work will be admitted unless a daily time-sheet for the same is handed to, or sent to, him on the following day.

(To this follow pages on which to draw up the number, nature, and position of the lamps, the descriptions of the route of each circuit, and a form of agreement to be entered into by the contractor.)

SPECIFICATION FOR THE SUPPLY AND LAYING DOWN UNDERGROUND OF ELECTRICAL MAINS FOR THE CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

The contracting company is the Callender's Bitumen Telegraph and Waterproof Company, Limited.

(1) *Route.*—The routes to be followed to be as nearly as possible those shown in the plans attached, but where necessary, by reason of unforeseen obstructions, they may be changed, subject to the approval of the Chelsea Company.

(2) *Excavation.*—The trenches to be made in the foot or roadways, as the case may be, on the route described. The depth under the footpaths shall be as little as is consistent with safety. When under the roadways the depth of the trench shall be 2 feet under, or such other depth below the surface level of the roadway as the nature of the paving or macadam may require. When necessary, to avoid existing obstacles, pipes, &c., this depth may be increased or diminished, subject to the conditions of safety.

(3) The existing paving of all kinds to be removed, and on completion of work replaced. The execution of the whole of this portion of the contract to be subject to the satisfaction of the surveyor of Chelsea parish, and to be carried out in terms of any orders or rules he may lawfully make, and to conform to conditions laid down in clauses 13 to 19 inclusive, and in clause 76 of the Chelsea Electric Lighting Order Confirmation Act of 1886, 50 Vic., cap. xviii.

(4) *Open Trenches.*—The work to be so carried out that no one section of greater length than 100 feet shall remain open for 48 hours.

(5) *Notices.*—All the notices which are laid down in the abovenamed Act as obligatory in connection with the works shall be given by the Chelsea Company, who shall relieve the contracting company of any responsibility in consequence of any neglect on the part of the Chelsea Company to comply with the requirement, but at the same time the contractors shall be required to give the Chelsea Company ample notice over and above the time of notices prescribed by the said Act to enable the Chelsea Company to fulfil its conditions; and, in case of the contracting company's defaulting to do so, the said company shall not be relieved from loss or responsibility arising out of any such failure on their part.

(6) *Plans.*—The plans and drawings made in duplicate, as prescribed by the said Act, shall be prepared by the contracting company and delivered to the Chelsea Company.

(7) *Deposit.*—Any deposit which the Vestry may require as a guarantee for the proper reinstating of the footpaths and roadways shall be made by the contracting company, and all arrangements connected with the same shall be made directly between the Vestry and the said company.

(8) *Negotiations with Vestry.*—Although the Chelsea Company shall give all the legal notices required by the Act, or otherwise, the negotiations with the Vestry, their surveyor, or contractors, as to the actual mode and time of doing the work shall be carried on by the contracting company, advice of same being given to the Chelsea Company.

(9) *Cable Cases.*—In the trenches, as described, cable cases shall be placed and jointed together into continuous lengths. The cases shall be of the Callender-Webber type, of the sizes and with the number of ways as specified in the schedule.

(10) *Cable Cases.*—The cases shall be made of the best bitumen concrete, of the same quality as those laid in 1887 at the Borough Road works of the Anglo-American Brush Electric Light Corporation, Limited. The thickness of material between the individual ways and between the ways and the outside of the case shall be at least half-an-inch. The inside of the ways shall be made truly circular in section and equal in area throughout, smooth and free from projections or roughness of any kind.

(11) The cases shall be made in lengths of 6 feet each, the ends trued to fit each other, and they shall be jointed together by means of saddle-pieces and bitumen cement, and with the assistance of suitable mandrills for each separate "way," so that the ways shall be equal throughout and watertight, and the inside of the ways at the joints in every respect of the same section, within at least $\frac{1}{16}$th of an inch, as smooth and free from roughness as elsewhere. Tight joints shall also be made between the E.M.F. draw and service boxes and the lengths of casing which join them.

(12) No bends shall be allowed of a shorter radius than * * *; they shall all be such as will allow the cables to be drawn in or out with ease, and the line of casing shall be laid out to avoid all unnecessary divergencies from the straight or level. No curved length of casing will be used in which the circular section of the ways has been altered in form by the process of bending.

(13) Drawing-in cords to be provided by the contracting company, and left in the ways as and when the cases are laid. When cables are drawn in, these cords to be used for drawing in the necessary drawing wires, which will be recoverable by or be returned to the contracting company, remaining their property in the interim.

Drawboxes.—(14) Drawboxes to be provided at all points as follows:—

(*a*) All change in direction of line of 90° or thereabouts, or where changes of direction prevent the use of curves.

(*b*) At all points of junction between one main and another.

(*c*) Sudden alterations in level.

(*d*) All straight lengths, in which boxes do not occur for the above reasons once in every 100 yards.

(15) The drawboxes must be securely joined to the main casing. The covers of the boxes to be of cast iron, resembling the Post Office specification of weight and thickness, and to be of the designs, dimensions, and patterns agreed on between the management of the two companies.

(16) If during the progress of the work it is found expedient to place additional boxes, this shall be done by the contracting company on orders being given by the Chelsea Company.

(17) *E.M.F. Boxes.*—The distributing or E.M.F. boxes to be placed at the points shown on the attached drawing and marked ——, or elsewhere, if required. They will be constructed of brickwork in cement, or laid in bitumen, and with floors and covers of best York landing. They will be constructed on the general design shown on the attached drawing, modified to suit the particular conditions of each case. The copper junction pieces to which the mains are jointed will be of special design, suitable to each position, and the joints with the same, and their insulation shall be made in all respects as mechanically and electrically secure as the joints in the rest of the system, described elsewhere.

(18) *Service Boxes.*—Service boxes to be of cast iron, and to be provided and fixed in number at least one for every two houses, as shown in schedule No. . These to be of the design, dimensions, and pattern agreed on between the two companies. Wherever possible only one line of distributing cables to be interrupted and pass through these service boxes. Service boxes and house connections to be fixed either at the same time as the casing is laid, or subsequently as found most convenient.

(19) The cables used to be made as follows:—

Conductor.—The strand to be of copper wire of high conductivity, guaranteed not less than 98 per cent. that of pure copper. Each wire to be tinned separately and to be of the size shown in schedule.

(20) *Dielectric.*—To consist of a solid sheath of bitite (vulcanised bitumen) put on under pressure to a diameter of not less than the dimensions named in schedule No.

(21) *Tapes.*—The cable to be taped over the dielectric three times with prepared tape and compounded between each. Braid to be of hemp yarn closely plaited and served with liquid bitumen compound, then with an asphalte compound, and finally passed through blacklead to facilitate drawing into the way. The cables to be coiled on large drums, having a boss of not less than 3 feet in diameter, and not to be subjected during manufacture or afterwards to any undue strain by bending or otherwise.

(22) *Joints in Cables.*—The joints between the sections of the cables, each to each, to be made by a long soldered joint in the conductor. The seven central wires to be run together solid, and each of the outer wires to be individually jointed to the corresponding wire in the other cable. The wires to be short and long alternately on each cable to form a strong marriage joint. The whole to be then bound with fine copper wire and soldered over all.

(23) This conductor to be lapped with tape, and then covered in not less than three thicknesses with sheet bitite, made specially

for this purpose. The whole to be well welded together, and to be finally protected by strong prepared tape and compound.

(24) Each joint when finished to be tested for insulation and conductivity. In each draw and distribution box a maximum of 2 feet and a minimum of 1 foot slack to be left on each cable for the purpose of allowing the sections of cable to be drawn backwards or forwards a few inches from time to time to prevent adhesion to the insides of the cases, and to secure their freedom and the possibility of at any time withdrawing the cables for the purpose of maintenance.

(25) *Service Joints.*—The joints of service leads to the mains for house supplies to be T-joints, and made as described above, except that the service wire will be jointed on the main by passing through the centre of the main, and lapping three times round the strand, the whole to be then firmly soldered and insulated as before described.

(26) In the service boxes care to be taken that the joint is as near as possible in the middle of the space, so as to allow the cable being safely moved when drawn periodically backwards and forwards to prevent adhesion. The service leads to have sufficient slack in the box to allow of this being moved without strain to the mains.

(27) *House Connections.*—House connections to be provided from each service box to within the boundary wall of the premises, and such connections to consist either of a two-way Callender-Webber case or of a cast iron pipe carrying two cables each of the size required to supply the current to be agreed on with the customers. A price to be paid for all such connections as shown in schedule No. . . This to include breaking through and making good the house or area walls.

(28) During the execution of the work the Chelsea Company to have free access for purpose of supervision to all parts of the work, and their representative to have the right to reject any labour and material which he considers in the interest of the work should not be employed, and upon receiving written notice to that effect from him the representatives of the contracting company will cease to use the same.

(29) Every separate length of cable shall be tested for its insulation resistance after having been drawn in to the casing and placed *in situ* before being jointed to the next length. The result of each such test must give infinity with a Wheatstone bridge, Post Office patterns, both between the conductors and between each conductor and earth; the current used to have an E.M.F. not exceeding 100 volts.

(30) The next test will be of the same lengths when jointed together from end to end from a station to a feeding box. From this test the same result will be required.

(31) Similar resistance results will be required from the distributing mains before the house service branches are joined in as from the charging and feeding mains.

DISCUSSION.

Prof. FORBES said: We have a good deal of matter to discuss in a short time, and I think many will agree with me that the paper which Major-General Webber has given is one of the most important papers that we have had on the subject of distribution of electricity. It is not a hypothetical paper in any way, it deals with what has actually been done by his company, and it is the first large scale application of storage batteries on this side of the water. Everyone must see, from the description that has been given in the paper, that every part of the scheme has been thought out with a care which is by no means common in central stations which have been devised on new plans. In every part of this scheme, whether it be in the arrangement of the batteries or in the motors, an enormous amount of thought has been bestowed, consequently this is one of the most interesting central stations that has been erected, and the working of which will attract a great deal of attention in the immediate future, financially and otherwise. There are some details which I should like to speak about, though not with the intention of criticism, but rather to draw attention to points which seem to be of special interest in the system which has been described by General Webber. The system of the distribution is very thorough indeed. There is only one or two points about which I do not quite understand. He has his feeders and charging mains distributing conductors all arranged in what seems to be an admirable manner, and, moreover, he has done what is a very desirable thing to do in the varying of potential, and that on a direct system of supply is a most important thing to induce counter electromotive force cells, such as he is introducing, when dynamos are being used, in order to adjust the pressure in the different feeders. One of the most interesting things is the system of conduits, that is, having a separate channel for each conductor. When we consider, however, it becomes a little difficult to see what the exact object of the conduit is, because if they were not waterproof, and did not act as air insulators, they can only be used as a protection for the cables, and the material being friable, steam rollers or pickaxes will be apt to break them; however, if the only advantage is the facility of drawing in and out cables it is a very great advantage indeed. As to the bare copper wire, we are indebted to General Webber for giving us results of actual experience. It has been very difficult to get actual experience. The fact that he was obliged to give it up makes one think that it was not so good as one thought. General Webber has not dealt with financial results in this paper. We shall look forward to financial results, for this is really the point which is of most interest. Everyone will agree that the storage battery system is better than any other which has been proposed, if the cost of maintenance and durability were sufficiently reduced. With regard to Mr. King's system of batteries, I have taken great interest in these, and seen not only what was done at Colchester, but at Millwall. Mr. Swinburne has drawn attention to the fact that very bad transformers are being made, and also to the fact that since many of the modern transformers have very largely lost through hysteresis, it would be much better to have open circuit transformers, to prevent this hysteresis from being injurious. At the same time, Mr. Swinburne is mistaken as to the figures being so very incorrect as to efficiency; the transformers were not in the most efficient condition, and those that I have examined myself have been higher than those which he has given here.

Prof. EWING: In connection with the meter which has been described, I should like to ask General Webber whether he has found in practice that there is any serious error in the readings of this meter on account of effects of retentiveness in the iron core which controls the indicator. When a strong current has been sent through the meter one may expect that subsequent readings will be unduly large as compared with those readings which follow a weak current, on account of the iron core retaining a portion of its previous magnetisation. In regard to Mr. Swinburne's paper, I do not think it easy to pronounce any opinion without having an opportunity of thinking out the matter more fully than one can do while hearing this paper read. The essence of the matter of his contention seems to lie in this: that in the magnetic circuit of a transformer you may, on the one hand, have a circuit consisting wholly of iron, a substance of great permeability, but, at the same time, open to objection on account of its dissipating energy through hysteresis, or, on the other hand, you may have a magnetic circuit in which a part of the circuit is formed through air, a substance having the drawback of being comparatively very impermeable, but having, on the other hand, the advantage that in magnetic cycles there is no dissipation through hysteresis. Mr. Swinburne's hedgehog form has a composite circuit, consisting partly of wire and partly of air, the spreading of the ends facilitating the connection between the two. It seems to me that a better result might perhaps be achieved by simply reducing the quantity of iron, and working with a higher induction, for one must bear in mind that the dissipation of iron through hysteresis becomes much less in proportion to the induction when the induction is high, that is to say, iron becomes, so to speak, more nearly elastic as regards cyclic changes of magnetisation the higher we go in the induction.

Prof. S. P. THOMPSON: It is quite true if you get the magnetic elasticity through magnetisation, you also do much work on the iron *in toto*, the iron would get very hot unless it had adequate surface. The real point of Mr. Swinburne's paper seems to be that he introduces into the magnetic circuit of the transformer a certain portion of air. Perhaps it is better explained by analogy. At one time it was thought better to regulate an alternating current systems by the introduction of resistance; now it has been found better to regulate the alternating current system by the introduction of reaction coils. If we were now to regulate the action of the transformer by acting on the iron part, we could do it by increasing magnetic resistance, either by putting in air-gaps or by thinning the iron. In one case thinning the iron leaves us in the presence of iron which dissipates energy by reason of its imperfect magnetic elasticity; in the other case introducing the air leaves us in the presence of a substance of which the magnetic elasticity is perfect. It has no residual magnetisation; the rapid reversal of its magnetic state engenders no heat and wastes no energy. Its action may therefore be likened rather to that of the choking coil than to that of an ohmic resistance in an electric circuit. I am not sure that I should agree with Mr. Swinburne's way of constructing this coil; what is the real gain of spreading out the ends of the wires into a hedgehog form, as he calls it? really, if the core is long, he cannot seriously diminish the resistance by spreading out in that way, and it adds to the difficulty of construction, and I am sure that it does notadd to the risks of the system. Mr. Swinburne does not say how long his cores are; of course, the question how far the resistance is effected depends on the length of that core. The meter described by General Webber is a very interesting addition to those interesting instruments, and we are all very anxious to know whether it is going to be the practical electric meter of the future. The subject of electric meters is one in which a great deal remains to be done. There is no one meter which shows itself superior to others, and we cannot point to one and say that is the right one to put into your house for your electric consumption. The difficulty of the properties of iron is got over by the most ingenious way of the so-called integrating piece. I should like to ask how the proper effect of that cam is found out: is it ascertaiaed once for all a certain piece of iron, or has every meter to be subsequently tested and the complicated cam cut for each.

Mr. POWELL was rather surprised to hear Mr. Hedges say that precautions were necessary to secure immunity from dangers to individuals.

Mr. PREECE: There is an immense amount of interest felt in the success or the failure of this system of distribution of electricity by accumulators in Chelsea, probably because the first attempt made at Colchester some years ago was a failure, but secondly, because there is a most remarkable and strange want of confidence in accumulators. Now, I find by experience this: that those who have no confidence in accumulators are those who never used them, while those who have used accumulators have very great confidence in them. I, as you know, have been a staunch advocate of accumulators from their very earliest introduction in this country, and my house for nearly six years was lighted by accumulators, and which are used very largely in the Post Office for telegraph purposes also, we have 300 circuits which have been working for the last four years; we are now introducing them for telephones. My own impression is that it is only a question of time to find the 30,000 cells that we have in use in the Post Office in London replaced by about 1,000 perhaps accumulators. Hence experience of accumulators is very much in their favour, and why it is that people do persist in decrying them I cannot make out. It may be due to one thing, they have been ill-used. People get batteries and fancy they will do a great deal, and they put in a great deal more current than they ought to receive; when accumulators are treated fairly and properly, when they are not overcharged, and when they are called upon quietly and gently, the life of a battery is really at the present moment unknown. I am quite prepared to say that their life is equal to a renewal of 15 per cent., and with coming years we shall be able to maintain our batteries with probably 10 per cent., we may even come to 7½ per cent. for renewals. We shall watch those experiments in Chelsea with interest, and look forward to have a report before this section from General Webber of the progress made at Westminster. There is one enormous advantage which General Webber has over those electricians who have been carrying out the system of distribution, for he has experience of underground wires and they have not. I do not know one thing where experience is wanted so much as in the knowledge of laying down wires underground and maintaining them. There was a terrible heresy committed in this room by Mr. Hedges, who spoke of the relative conditions of underground wires and overground wires, he spoke as though an underground wire gave no insulation whatever, and that the insulation of an underground system was far inferior to that of an overground system; the reverse is the case; underground systems not only give a very much higher insulation, but you can rely upon the uniformity of the insulation of underground, while the insulation overground is very variable and troublesome. There was one other thing that Mr. Hedges referred to, and that is the statement that the London Electric Supply are going to use mains with one conductor put to earth; that is not true; there is a system, and a very delicate system, used at the present moment in all our principal towns, and that is the system of Telephone Exchange, and if the outside conductor of such a main as that proposed be laid down, and if the outside conductor were put to earth, it would entirely upset the whole telephone system in London. We cannot allow that, and the Government has been obliged to step in and say that the outside conductor shall not be put to earth, you must provide something else; and the result is, the main which the London Electric Supply Company are going to lay down has the outside conductor very carefully insulated. It is a concentric cable, a solid wire in the centre which is insulated; outside this is a cylinder of copper, also insulated and covered with wire, and I hope it will answer the purpose. With respect to Mr. Swinburne's paper, I have very few remarks to make; these are the kind of papers we want, and when we find men deliberately set to work with the experience and mathematical knowledge of Mr. Swinburne, we can only hail such papers with great pleasure. There is one point he has not touched upon; he alluded to the fact that these transformers may cause an immense amount of waste when the instruments are laying idle. At the present moment they are devising switches by which the transformers shall be switched off during the day and switched on only when wanted at night. One word as regards the dangers. When I spoke the other day, I referred solely to dangers to persons, and to-day we have heard more of dangers from fire. It is a great mistake to imagine that in an electric lighting system you are entirely free from risks of fire. It is often said have electric light, you will be absolutely safe. There is no fear of your house being burnt down. It is a mistake. There is not the slightest doubt, there is as much danger in regard to fire by introducing the electric light as there is from introducing gas. In the electric light the chief danger arises from the use of imperfect material, and especially from the employment of inexperienced men; also from the want of just those very contrivances which Mr. Hedges has brought before us. If good material is used, if experienced men are employed, and if all the apparatus of safety, such as we have heard to-day, are admitted, then electric lighting is absolutely safe, but not unless you do something of this sort of thing. As regards danger to persons, that is quite a different thing. I alluded the other day to a strange remark made by Mr. Stevenson, one of the reasons he adduced against the use of the distribution of power by means of electricity was, that if a man touched a wire he would be killed, that is—in unscientific language—absolute rot (laughter and applause); the difficulty with electric currents is not to prevent a man from killing himself, but to know how to kill him. The State of New York recently passed an Act making execution by electricity in the future; they have not rescinded that Act, yet they will be obliged to do so, because they cannot find an electric current to kill men with certainty. I remember on one occasion making some experiments with enormous induction coils with a spark about 5 inches long to kill a rabbit, and we could not; they volunteered to try me, but I was not quite ready to offer my body at the present moment, but there are many of us who have taken immense shocks. Colonel Armstrong, at Chatham, took shocks that were supposed to kill individuals, but he was very well after it, and looked all the better after it. I can say this, speaking from experience, that there is absolutely, with ordinary precautions, no danger to persons and no danger to life. Newspaper correspondents are very fond of getting up some sensational paragraphs. There was a case in Brighton where a brewer's man was stated to be killed by the electric lighting currents. The man was certainly dead, he was found resting against the wire, there was a mark on the back of his neck, but the fact was the electric light current was put off two hours before the man was supposed to be killed, so it is doubtful whether the man in Brighton was killed by the currents generated by the central electric lighting station there.

Mr. Webber: I thank Prof. Forbes for the friendly way he has spoken of my system. As regards the E.M.F. cells, I beg to remind him that the E.M.F. cell is considerably above the standard of distribution of pressure required in the mains, and that they are destined, as it were, to keep down the excessive pressure at the commencement of the discharge.

Mr. Killingworth Hedges said, in reply to Mr. Powell, that the question of fire risks is practically settled, and danger is minimised. I think Mr. Preece can hardly have meant the insulation of underground system is perfect. I happen to have the discussion on the paper read in 1888 on the distribution of electricity. I have also the remarks of Captain Cardew, who is the Board of Trade inspecter referred to by Mr. Preece, and he says the question has given anxious consideration to Government, and in all underground systems there is the danger of leakage.

Mr. Swinburne: Prof. Forbes pointed out that the Gaulard and Gibbs transformers gave very high efficiency. I think it is about 88 per cent., and that is rather a confirmation of my paper. They were not the best designed, being rather long. It was also mentioned that open circuits were more efficient. There was a loss owing to the free magnetisation. I do not know whether I am quite accurate in saying that, but that was my impression of the reason given before. Prof. Ewing says that the iron ought to be reduced. In the paper I have taken several inductions, and high induction induced rather low efficiency. I do not quite follow Prof. Ewing's figures, for the loss of c.c. were taken as one cause, and what he calls graded cycles. Prof. Thompson does not quite follow the advantages of the spreading out of the ends. I do not like to use the term "magnetic resistance;" hedgehogging makes the magnetic resistance of the air enormously smaller.

REPORT OF THE COMMITTEE ON CERTAIN MOLECULAR PHENOMENA CONNECTED WITH THE MAGNETISATION OF IRON.

(*Read by* Prof. Barrett *on September* 13*th*, 1889.)

At the meeting of the British Association at Bradford in 1873, a paper was read by the Secretary of this Committee, and subsequently published in the *Philosophical Magazine* for December, 1873, "On certain remarkable molecular changes occuring in iron wire at a low red heat." In this paper the phenomenon known as the *recalescence* of iron was first published, it having been discovered by the author early in September, 1873. At the suggestion of the late Prof. Balfour Stewart, a small committee was appointed, of which Prof. Barrett was appointed secretary, to investigate and report on recalescence and other molecular phenomena attending magnetisation. This committee had some meetings, and a good deal of unpublished experimental work was done by the secretary, but no quite satisfactory explanation of the main point, the phenomenon of recalescence, was arrived at. The lamented death of the two principal members of the committee, Prof. Clerk Maxwell and Prof. Balfour Stewart, left the matter in abeyance, and the committee lapsed before a report was presented. Recently, however, the committee has been reappointed, and now consists of Prof. Fitzgerald as chairman, Mr. Trouton, Mr. Newall, and Prof. Barrett as secretary. Owing to various causes it is not proposed on the present occasion to do more than present a formal interim report reserving to next year the full report of the committee.

So much work has of late been done on the general subject of the molecular phenomena attending magnetisation that it would now be beyond the scope of the committee adequately to report on the whole matter. We propose, therefore, in the first instance, to confine our report to those phenomena accompanying the so-called critical temperature of iron—that point in, or near, which the magnetic state is lost in heating and regained on cooling. Here, at a dull red heat, a series of profound and remarkable changes occur in iron and steel, to which attention was first called by the paper read by Prof. Barrett in Bradford in 1873. The principal points in that paper were as follows:—

"1. Mr. Gore, in 1869, had discovered that a momentary *elongation* of iron occurred in cooling after heating a wire of that metal to a white heat. In 1873 the author found a similar but reverse action took place in *heating* the wire. 2. This anomalous deportment was found, both in heating and cooling, to coincide with, on the one hand the *loss*, and on the other with the *resumption* of the magnetic state of iron or steel. 3. At the critical temperature the wire, having cooled down to a dull red heat, suddenly flashed into a bright glow; likewise during the *heating* of the wire the temperature remains stationary for a short time when the critical temperature is reached; a rise in the specific heat of wire and steel therefore occurs at the critical temperature. 4. A curious crepitation occurs at the critical temperature, similar to that heard in the magnetisation of iron, or in the production of the scales of oxide on the wire. 5. Prof. Tait's remarkable thermo-electric change in iron occurs at this same temperature. 6. Hard iron wire and steel wire exhibit recalescence, but certain specimens of good soft iron failed to show it, and even in the wires that exhibit it the phenomenon grows less marked after repeated heating and cooling."

To these observations may be added that a recent investigation by Prof. Barrett on the properties of 14 per cent. manganese steel wire (Proc. Royal Dublin Society, December, 1886), shows that this body, which is almost a non-magnetic metal, does *not* exhibit the anomalous deportment observed in ordinary steel wire. This fact is of considerable interest as linking the foregoing phenomena more closely with the magnetic state of iron and steel.

Estimating the temperature of the critical point in various ways approximately from the expansion of steel and of platinum brought to the same, when it was found to be approximately about 800° C.

When we remember that the mechanical, electrical, and thermal properties of iron and steel are of the utmost practical importance, and that all these properties appear to undergo a remarkable change at the critical temperature, the need of a searching investigation on the question is obvious. Moreover, the interest is no less, from a theoretical point of view, in connection with theories as to the molecular structure of magnetised iron and steel.

Recalescence being feeble in soft iron, more marked in hard iron, and most in steel, it was conjectured by the author in 1873 that the phenomenon might be due to an action depending on the presence of carbon in iron, creating an effect analogous to that observed when water or super-saturated solutions are cooled below the solidifying point; a slight disturbance thereupon producing a sort of explosive action, solidification occurring with a sudden rise of temperature. Prof. Roberts-Austen has drawn my attention to the fact that lately M. Osmund, in France, has made recalescence the starting point of a new enquiry, tracing the effects of carbon, Mn, Cr, S, P, and Si, on the points at which recalescence occurs or is destroyed by the alloy. That whilst *pure* iron does undergo a molecular change at a red heat, carbon retains its position as an important factor in determining the point of recalescence in hard iron and steel. Messrs. Barus and Strouhal have recently published in America a series of important papers on the tempering of steel, and shown that a critical temperature of between 500° and 1000° C. exists which is intimately connected with the hardening or annealing of steel. They also draw attention to the numerous phenomena observed to occur at this temperature, but appear to be ignorant of Prof. Barrett's prior publication. Numerous other experimenters have worked at recalescence, notably Mr. Tomlinson of King's College, and Mr. Newall, at Cambridge, but the bibliography and discussion of the whole subject will be reserved to the report next year.

NOTES.

Edinburgh and the Electric Light.—At a meeting of the Edinburgh and Leith Gas Commissioners held on Monday, the Works Committee reported that having considered the attitude to be assumed by the Commissioners towards the electric light companies who desired to supply light and power to Edinburgh and Leith, it had been resolved to recommend the Commissioners to refuse their consent to any of these companies obtaining provisional orders. The minute was approved, and the Commissioners agreed to adjust a resolution which would be disposed of at a special meeting to be held at the end of October.

Portsmouth New Town Hall.—It has now been decided to introduce the electric light on a somewhat extensive scale into the new Portsmouth Town Hall, and a committee have accepted the tender of Messrs. Haden and Son, of Manchester, for the necessary installation.

Electric Lighting in Madrid.—At last, says *Industries*, there seems to be a chance that the English Company, which made proposals to supply electricity at Madrid, will have the courage to fight the influential gas company, which has hitherto always had its own way at the high price of 9s. per 1,000 feet, and has been fortunate enough to stop all electrical stations which have been proposed for Madrid. A very suitable site has been chosen for the central station, which will have sidings to discharge the coals direct from the waggons. Mr. Phillips is to be the local manager of the company, and it is proposed to commence with 4,000 horse-power. Public opinion is now so favourable to the electric light, that, if the new company supplies at a reasonable price, I believe every gas light will be changed for the electric light, unless the price of gas is reduced to one-half its present rate.

Gas v. the Electric Light.—Mr. C. E. Botley, A.M.I.C.E., engineer to the Hastings Gas Company, recently delivered a lecture at the Gas Exhibition, in the public hall, Hastings, on the uses of gas and the sanitary aspects of gas compared with other illuminants. Mr. Botley prefaced his remarks with a short description of the nature of gas, and said that if the same amount of trouble were expended on gas lamps as on those of the electric light much better results would be arrived at. Lighting and ventilation were so closely allied that the faults of the one were attributed to the other. It was possible to efficiently ventilate without draughts, and whether the illuminant was oil, gas, or the electric light ventilation was imperatively necessary. Gas did not contain the amount of sulphur generally supposed, for if it were kept alight all day in a closed room the amount of sulphur evolved would be only equal to that obtained by striking an ordinary lucifer match. The lecturer said he had had great experience in all branches of electric lighting, and he almost invariably found that in a badly-ventilated apartment the electric light from a sanitary point of view was worse than gas. This was no theory of his own, for it was a well-known fact that at many of the London theatres where the electric light has been installed gas has been laid on as well for ventilating purposes. The cause of this was that the heat of the electric light was often not strong enough to force out the vitiated air; and thus it was that the atmosphere was rendered unbearable.

Electric Lighting at Exeter Theatre.—On Monday evening the installation of the electric light, which has been supplied by the Exeter Electric Light Company at this theatre, was used for the first time. The circuit included 450 Edison-Swan lamps of 16 C.P., which were set aglow from the company's depôt in New North Road. The experiment was extremely satisfactory. The lamps burned without a flicker, and Mr. Massingham, the manager of the company, and Mr. Albert Jones, the electrician, made a satisfactory examination of the circuit.

Electric Light at Wickwar.—The electric light was used for lighting the streets on Monday night for the first time this season. The alterations which have been carried out since last winter were a decided advantage, but one or two more lamps were needed on the Chipping Sodbury and West End Roads to make it the desired success.

The Electric Light for Dundee.—At a meeting of Monday of the committee of the Dundee Gas Commission a verbal report was given regarding the various systems of electric lighting in London, Paris, and other cities which had been inspected by a deputation from the Board. The deputation were unanimously of opinion that the Board should acquire power to supply the electric light, and prevent any private company undertaking the work. It was arranged that the deputation should present a written report to the monthly meeting of the Commission.

Electric Lighting at Cardiff.—The County Council, at their meeting on Monday, resolved to oppose the granting of provisional orders by the Board of Trade to any of the 12 electric lighting companies who have applied for powers to light the streets of Cardiff by electricity.

Lecture on Electric Lighting.—In connection with the University Gathering at Glasgow Dr. Elliot delivered on Tuesday evening his second lecture on "Electric Lighting, the Transmission of Power." The lecture was devoted to an explanation of the currents of electricity as utilised by the dynamo.

Electricity in Mills, &c.—Last week, before the South Staffordshire Institute of Iron and Steel Works' Managers, a paper on "The Application of Electricity to Works and Mills" was read at Dudley by Mr. T. Vaughan-Hughes, F.I.C. The author confined his remarks principally to references to existing transmission power plants, especially those in Switzerland, Italy and America; but as nothing new was brought forward in the paper, we refrain from giving an abstract of it.

Electricity in Mining Operations.—In the last issue of the "Transactions" of the Liége Society of Engineers, M. Joseph Libert, mining and electrical engineer at Liége, contributes a paper on the "Firing of Shots in Mines by Electricity." After referring to the firing of shots by means of the electric current from induction coils, accumulators, dynamos, static machines, &c., the author comes to the conclusion that electrical energy employed for ignition purposes in mines is an indispensable necessity where flameless explosions are used, and he expresses the opinion that electricity in mines will soon come into greater favour. This is certainly a step in the right direction, and M. Libert's communication will be placed for consideration before most, if not all, of the Belgian mine owners. We should like to see a similar policy pursued in this country.

Electro-Physiology.—*Apropos* of electrical execution, and the dangers of electric light currents, the report of M. D'Arsonval to the International Congress of Electricians on Electro-Physiology, which appears in the columns of our present issue, might be studied with advantage by those interested in the subject, and by those who express opinions on the same without proper consideration.

A Suggestion.—The Leeds Corporation have for a few years been considering the advisability of having erected a central electric light station. They have even got so far as to have a small installation put up, but now the central station idea is again to the fore. There is also another matter which is receiving a great amount of attention, and that is, as to whether or not the local tramway lines, &c., are to be purchased by the council. An agreement has been drawn up between the members of the Highway Committee and the Tramways Company, under which the Corporation are to purchase at a valuation the tramlines, &c., and lease them to the company for 21 years. The Corporation can, however, acquire the tramlines in three years time according to powers invested in that body. Now, since the Leeds Council intend to have a central electric light station, we think they might kill two birds with one stone, that is to say, they could have the station erected and plant installed of sufficient power, not only to supply current for lighting purposes, but also for the electric propulsion of the tramcars, which, together with the lines, &c., can be acquired as already mentioned in three years. This would be far preferable to steam tramcars which it is proposed to introduce on a larger scale over the whole system of tramlines in that town, provided the aforesaid agreement be carried out.

Brush Electric Hoist.—This is a compact combination of an electromotor with a winding drum for hoisting purposes. The motor is of 15 H.P., and is mounted on the same base as the hoisting drum, which is of the Walker pattern. The Brush Company of America have contracted to equip the copper mines of the Calumet and Hecla Company at Calumet, Mich., with five 80 H.P. motors and five 130 H.P. dynamos.

Primary Batteries.—On reference to our list of "New Companies Registered," the nearly-forgotten Maquay inventions will be noticed as undergoing resuscitation.

Miracle Working.—The Croydon *Chronicle* of September 28th says:—This week the value of electricity as a curative agent has been brought before Croydon audiences at the Public Hall by Mr. E. Moross, medical electrician, who came with a rather strong flourish of trumpets from Manchester and London. The hall was about half full on Monday night, when Mr. Howard, the Professor's agent, stepped on to the platform, and remarking that it was necessary for him to offer some introductory and explanatory remarks, as Mr. Moross was not proficient in the English language, he proceeded to dilate upon the success which had attended the Professor at Manchester. Mr. Howard then gave way to the Professor, who evidently believes in effect. He entered with a dramatic air, which was heightened by dark "bushy locks," and a heavy black moustache, and spoke with a tongue more French than English. He remarked that he was not cut out for long speeches—his knowledge was not of words, therefore he would proceed to demonstrate with facts. Before commencing, however, he remarked upon the utter uselessness of so-called electrical goods that were offered for sale, stating broadly that so-called electric belts were of no more use than a piece of flannel. He then introduced his electric chair, explaining its simplicity and properties, also the electric carpet, which was exhibited. A man suffering from partial paralysis was treated, and was enabled to lift his arm, and lift a chair with it, which he had been unable to do before. On Tuesday evening the lecture was again repeated, the hall being about three parts full. A man with a bad leg was enabled to leave the platform in a somewhat nimble fashion as compared with the assistance required to get him up there. The man who on Monday evening was treated for paralysis of the arm was called up, and he declared he was all the better for the treatment. He said he had been unable to raise his arm previously except by force, and he swung it about to exhibit to the audience how well it had been relieved. On Wednesday evening the hall was crowded. A woman between 30 and 40 years of age was lifted on the platform in a chair, and her husband stated that she had been unable to walk or stand for eight years. The Professor said this was a bad case, and if he succeeded in enabling her to stand it would be something. He then proceeded with his treatment, and after about ten minutes lifted her from the chair, and stood her up, when she managed to "shuffle" across the platform. The next case was that of a man aged 65, who had been a cripple for 10 months. He was assisted on the platform, and the Professor at once threw his two sticks, which he had declared he could not do without, back into the hall, stating he would go home without them. He treated him, and then told him to walk alone across the platform, which he did, at first gently and carefully, and then accelerating his pace until he got up to a fairly good trot. He then walked off the platform, and up and down the room, amid general applause.

Improvement in Electric Fittings.—Everyone who has had any experience with the small details of electric lighting knows the annoyance and trouble caused by the invariable bad fittings of porcelain parts which depend upon a screw for their connection. To remedy this, Messrs. Girdlestone and Tatham have devised and patented a simple form of connection between the base and cover of such fittings, which entirely obviates the difficulty, without increasing the cost. A ring is formed on each part, and portions cut away, the parts left standing are slightly wedge-shaped, and by a slight twist lock together quite as firmly as a good fitting screw thread. In an average lot the covers and bases are perfectly interchangeable, which is never the case with the best screwed work. Messrs. B. Verity and Sons, of Covent Garden, are using these fittings largely, and they give great satisfaction. The joint is applicable to all such fittings as switch covers, bell pushes, cut-outs, &c., and we think that it will be found generally acceptable to the trade.

Electric Traction.—Mr. Jarman writes to us as follows :—"The facts contained in my letter published in the ELECTRICAL REVIEW of September 20th are indisputable, and can be more than fully supported and substantiated by evidence both personal and documentary. Sandwell's statement that he offered certain improvements to me is absolutely untrue. Any idea of improvements he may have had must have been kept to himself. The suggestion of simply attaching the trolley (I had already designed) to the car as a special tender was neither new nor novel. The use of a special tender containing storage cells, to be attached to a car or locomotive, is described in patent No. 15,277, of 1885. It was therefore common knowledge at that time. The following words occur in the above specification, lines 1 to 5 in the provisional : 'This invention relates to the construction of an electric locomotive in such manner as to effect the traction of ordinary railway trains, *tramcars, and the like.* The locomotive can be actuated from any source of electricity, such as batteries or accumulators carried by it, *or by special tender*.' The same words are quoted in the complete specification, page 3, lines 5 to 9. There cannot be much doubt about this constituting prior publication. As to the personal remarks make by Sandwell, I deem them unworthy of notice. With this letter I enclose specification, No. 15,277, and two others, all carefully dissected, which will enable you to form your own conclusions."

Awards at the Paris Exhibition.—The following firms connected with the electrical industries were awarded prizes :—

Acme Electric Works	Honourable Mention.
Automatic Electrical Corporation	Bronze.
Aveling & Porter	Gold.
Avery, W. and T.	1 Silver, 1 Bronze.
Brotherhood, Peter	1 Gold, 1 Silver.
Clark, Muirhead & Co.	Gold.
Crompton & Co., Limited	Gold.
Crossley Bros., Limited	Gold.
Davey, Paxman & Co.	1 Gold, 1 Silver, 1 Bronze.
Davis & Timmins	Bronze.
Doulton & Co.	Grand Prix, 2 Gold, 1 Bronze.
Eastern Telegraph Co.	Gold.
Electrical Power Storage Co.	Silver.
Elliott Bros.	Grand Prix, 1 Silver.
Elliott, Samuel	Silver.
Globe Electrical Engineering Co.	Honourable Mention.
Greenwood & Batley, Limited	Gold.
Henley's Telegraph Co., Limited	Silver.
Hermite	Silver.
Humphreys, James Charlton	Gold.
Johnson, Matthey & Co.	2 Grand Prix.
Paterson & Cooper	Silver.
Selig Sonnenthal Co., Limited	1 Silver, Honourable Mention.
Timmis, Illius	Silver.
Unbreakable Pulley Co.	Honourable Mention.

Action of Cardiff Telegraphists.—Advantage is about to be taken of Mr. Raikes's visit to Cardiff to place before him a matter which has for years caused a deep and general dissatisfaction among provincial telegraphists and postal *employés*. Described briefly, the latter complain—and justly, we think—that they alone, of all the various classes in Government employ, receive no pay for Sunday work. Their claim derives exceptional strength from the fact that the concession denied to them has been conceded to their fellows in London. Hence occurs the anomally that while the manipulators of the wire at one end receive payment those at the other end do not.

Electrical Engineering in Vienna.—The International Electrical Company of this town have just sent out circulars in which they announce their intention ot erecting on the shore of the Danube, in the neighbourhood of Vienna, a large central station for the supply to consumers throughout Vienna. The alternate current system of Messrs. Ganz & Co. will be adopted.

The School of Electrical Engineering and Submarine Telegraphy.—We are informed that as the result of the examinations for the certificate of this school, recently conducted by Mr. Gisbert Kapp, A.I.C.E., the following gentlemen have obtained the certificate in electric lighting and power transmission : Messrs. H. E. Bartlett, S. Bone, J. H. Bomver, Junr., J. A. Fraser, W. C. Goodchild. The candidates had to answer two papers, one in mechanical and the other in electrical engineering, and had also to pass a *viva voce* and practical examination. The minimum required in each paper was 60 per cent. and for the practical examination 70 per cent. The course of 12 lectures on "Dynamo Machines," to be delivered (from the middle of the present month) at the above school by Mr. W. B. Esson, will, we understand, be fully illustrated by machines, &c., of the various types in actual use, and will be thoroughly practical in their character.

Telegraphy Examinations.—At the recent "telegraphy" examination of the City and Guilds of London Institute five telegraphists from the Hull Postal Telegraph Office passed, all of whom were ladies.

The Society of Engineers at Deptford.—A representative body of this Society visited the Deptford Electrical Works on Wednesday.

Torquay Telephone Exchange.—This exchange, which is conducted by the Western Counties and South Wales Telephone Company, is making satisfactory progress. The list of subscribers musters nearly 140 names, including those of the principal tradesmen and professional men of the place. The trunk line connecting Torquay with Plymouth, which is 40 miles distant, is found to work remarkably well, and is a great boon to the commercial population of both towns. The line is described as perfectly clear, and as free from any interruption whatever as the short-distance wires. It may be added that the average daily calls at Torquay in connection with the exchange number close upon 500.

The Electrical Power Storage Company.—The silver medal awarded to this company at the Paris Exhibition is for the E.P.S. system of public supply of electricity from storage batteries (King's patents), which system is now at work in the Chelsea Electricity Supply Company's Central and Sub-stations in the Parish of Chelsea, the distribution taking place from two substations. That company has a third sub-station completed, but not yet in operation.

The Building Act and Electric Lighting.—At the meeting of the London County Council last Tuesday the Building Act Committee recommended, and the Council agreed, that the application of Mr. R. Walker, on behalf of the Metropolitan Electric Supply Company, Limited, for approval of a plan for the construction of a furnace chimney-shaft at South Mews, South Street, be granted, upon condition that the foundation of the proposed shaft be made in accordance with the provisions of the Building Act, 1855, and to the satisfaction of the District Surveyor according to law; that the superstructure be also erected to his satisfaction, and that, if the plan or application be hereafter found to be inaccurate in any particular, the approval of the Council shall be null and void. The same committee recommended, and it was resolved that the application of Mr. C. B. Waller, on behalf of the London Electric Supply Corporation, Limited, for approval of the construction of an open wood and iron shed at the Adelphi Arches, be not granted, as the construction is not in conformity with the Building Act.

The Strand.—*Money* says: "Another pleasant prospect is in store for the Strand ratepayers. According to Sir Coutts Lindsay, that thoroughfare, which has just been 'up' for five weeks, during the work of laying down the mains by one electric light company, will soon have to be taken up again to allow of the laying of the mains of Sir Coutts Lindsay's company. Truly this is a nice state of affairs."

The Bell Telephone Company.—This company has filed a suit in the courts at Cincinnati, Ohio, asking heavy damages from two Cincinnati electric street railroads, and that they be compelled to so arrange their electric plant as not to injure the Bell Company. This will be a test case, as the same complaint exists in other cities. Telephonic communication with Mount Auburn, Clifton, Carthage, Ivorydale, and other places near Cincinnati, is said to be almost ruined by the induction of the powerful wires of the electric railway.

Another Death from Electricity.—An Italian was killed a few days ago in New York by contact with an electric wire belonging to the United States Company. It was in the middle of the afternoon, when no lamps were burning. Climbing over the top of a fruit stall his foot slipped, and he caught at the wire and was killed.

Electrical Engineering Appointments.—Mr. James Raeburn has just been appointed an electrician to the Thomson-Houston Company at Hamburgh. Mr. Herbert E. Sturr has also been appointed to the Central Electric Lighting Station at Exeter, and Mr. Arnot has gone to Melbourne to fit up an electric tramway and represent a well-known electrical engineering firm, at £500 per annum. These young men were all students of the Glasgow and West of Scotland Technical College electrical engineering classes.

Messrs. Elliott Brothers' Paris Exhibit.—It will be seen from the list of the awards at the Paris Exhibition that Messrs. Elliott Brothers occupy the proud position of being the only English firm showing anything in connection with electrical work of any kind, who have been awarded the "Grand Prix."

To Electrical Engineers.—The lease of the premises occupied for many years by the late Sir Charles Bright is advertised for sale, as well as his scientific instruments, tools, machinery, books, and office furniture. This appears to be a good opening for an electric light company, or an electrical engineer with pupils.

The Sunbeam Lamp.—At the recent meeting of the British Association at Newcastle, the large halls in which the *conversaziones* were held were lighted with excellent effect by means of Sunbeam lamps of 300 C.P., and on one occasion a lamp was used of 3,000 C.P., which is said to be the largest incandescent lamp ever made. We understand that considerable improvements have been made in the manufacture of these lamps by the manager of the company's works, Mr. John W. Edmundson, resulting in a considerable reduction in the selling price of the lamp.

The Junior Engineering Society.—Friday, October 11th, inaugural meeting of Ninth Session at Westminster Palace Hotel, Victoria Street, S.W. Prof. John Perry, D.Sc., F.R.S., will deliver an address on "Mechanical Engineering in Electrical Industries."

NEW COMPANIES REGISTERED.

Electrical Accessories Company, Limited.—Capital £5,000 in £1 shares. Objects: To carry on business as mechanical, electrical, gas, and general lighting engineers, electricians and suppliers of electricity for all purposes, and as manufacturers of electrical apparatus. Signatories (with 1 share each): Bernard Meryn Drake, J. Marshall Gorham, 2, Princes Mansions, Victoria Street (electrical engineers); A. D. Stevenson, electrical engineer; F. C. Read, 66, Victoria Street, S.W.; Sarah Atkins, 172, Hockley Hill, Birmingham; Walter Atkins and E. E. Atkins, Handsworth, Birmingham. Table A of the Companies Act, 1862, will regulate the affairs of the company. Registered 28th ult. by W. L. Cooper, 29, Essex Street, Strand.

Economic Gold Extraction Company, Limited.—Capital £175,000 in £1 shares. Objects: To acquire and deal with mineral, chemical, and electrical properties and inventions. To acquire certain patent rights of the Hydrogen Amalgam Company, relating to an electrical process for the economic extraction of gold and silver. Signatories (with 100 shares each): *Alderman Joseph Renals, 8, Falcon Street, E.C.; *Wm. Strapp, Redhill; *B. Depledge, 3, Gracechurch Street; H. T. Walker, 36, Wickham Road, S.E.; D. Russell, 4, Tokenhouse Buildings, E.C.; F. B. Seaton, 27, Newbury Street, S.E.; *C. B. Cousens, C.E., 2, Clanricarde Gardens, S.W. The first directors are the subscribers denoted by an asterisk, and John Grove Johnson, A. P. Matheson, F. W. Browne, and B. C. Molloy, M.P. Qualification, £100 in shares; remuneration, £1,300 per annum, divisible. Registered 28th ult. by Slade and Munk, St. Clement's House, Clement's Lane, E.C.

Maquay Syndicate, Limited.—Capital £12,000, in £100 shares. Objects: To acquire inventions for an improved voltaic battery, for improved means for feeding electric batteries and for removing the plates therefrom, and for a miners' lamp; Nos. 15,040 of 1885, 990 of 1887, and 14,932 of 1888. Signatories (with 1 share each): R. H. Parkinson, 62, Greenwich Road; C. A. Griffith, Queen's Road, Forest Hill; L. F. Paine, Addlestone, Surrey; R. Rowe, 31, Horton Lane, Hackney; C. Bryan, West Walthamstow; J. Mansel Jones, 159, Victoria Park Road; G. May, 200, Coldharbour Lane. The signatories are to appoint the first directors, and the company in general meeting will determine remuneration. Registered 28th ult. by Johnson, Budd and Johnson, 24, Austinfriars.

AMERICAN NOTES.

By DAS TELEPHON.

Telephone matters are just now occupying a great deal of attention from capitalists, and the American Bell Telephone Company, who own all Bell's and Edison's and others' patents, have taken advantage of the telephone craze, and have increased its capital 25 per cent. by adding *water* to its already much diluted capital. The new *water* represents two and a half millions of dollars.

The American Telegraph and Telephone Company, better known as the Long Distance Telephone Company, are rapidly pushing its wires south, so that in a few months their new metallic circuits will extend from Boston, through New York, Philadelphia, Baltimore to Washington.

The Chesapeake and Potomac Company, owning the licence for Maryland and District of Columbia from the American Bell Telephone Company, with connections through its exchange in Baltimore, have connections with all the cities and towns within a radius of 100 miles.

The capital of this company is $1,650,000, and the yearly dividends average 5 per cent. It has 7,000 miles of wire in Maryland, of which 2,000 are in Baltimore. In the Baltimore exchange 35 girls do the talking, and they are paid $20 a month. This company are now preparing to put its wires underground in this city. The charges for city service are as follows:—Club wire, used by an unlimited number of subscribers, $60 per year to each; exclusive private wire $100 per year. With a population of 350,000, there are 4,370 subscribers.

In Washington City this company has 1,737 subscribers and 3,156 miles of wire, of which 1,600 is underground. The rates in Washington are—private wire, $100 a year; two or more on one wire, $80; private residences, $72; two or more on same wire, $60. The metallic circuit on all its lines is to be established as soon as the conduits are ready, in which 150 cables, each containing 100 wires, are to be laid.

In Philadelphia there are 3,000 subscribers, with a population of one million. The rate on the exchange is $120 per year. There are 42 public telephone stations; the charge for using the telephone is 10 cents for five minutes.

The Philadelphia Bell Telephone Company is now laying tubes about 2¼ inches in diameter. These tubes are laid in cement, and through these tubes lead covered cables are drawn containing about 50 insulated wires each, and these wires are connected to poles in the centre of each block of houses, and thence distributed to the houses. The long distance telephony is also being put in operation, thus connecting Philadelphia with cities and towns in a radius of 100 miles. The subscribers complain of the high rates —$120 a year. Some attempts have been made to get up a rival telephone company to use the Bonta telephone, said to operate on the make-and-break system, but it necessarily was a failure, for the simple reason that the Bonta telephone is purely a carbon microphone.

The New York and New Jersey Telephone Company covers Brooklyn, Jersey City, and a radius of 33 miles from the City Hall in New York.

This company has 7,000 subscribers in a population of three millions, and the charge is from $80 to $100. In New York City it has 6,800 miles of wire. This company is declaring dividends of 85 to 90 per cent. a year, besides hoarding up a large surplus.

The electric companies of all kinds in New York have grown to enormous proportions, nine of them supplying light and power. The generating room of the Brush Company is the largest of its kind in the world.

Baltimore, *September 15th.*

CITY NOTES, REPORTS, MEETINGS, &c.

Electric Construction Corporation.

THE first ordinary (statutory) general meeting of the Electric Construction Corporation, Limited, was held last Friday at the offices of the Corporation, Worcester House, Walbrook, Sir Douglas Fox, J.P., presiding.

The Secretary (Mr. F. Walton) having read the notice convening the meeting,

The Chairman said: Well, gentlemen, as you are well aware, this is our statutory meeting; therefore we have no report to present to you, nor are there any resolutions to be proposed; but I need hardly say that it is a great pleasure to the directors on this, the first occasion, to be able to meet the shareholders face to face, and to exchange a few ideas with reference to the present position, and the possible future of what we believe to be a most important corporation. I may say, to begin with—it is perhaps a most important point—that all our capital was fully subscribed, and I don't think you could easily find a company of this size whose capital is more strongly held than ours is at this moment. Another point, which is very important, is that our works are fully occupied. We have as many orders as we can execute, and we could easily have a great many more if we could only execute them. I think, as you look at the gentlemen on my right hand and on my left, you will feel that there are practical men amongst us, and we are naturally inclined to be cautious in what we do; at the same time, our chief difficulty at this moment is that we have not room enough in our works to enable us to extend our business as we should wish. The consequence is that the first attention of your directors has been given during the few months which have elapsed since this comnany was formed to laying out very carefully and preparing to immediately erect extensions of our works at Wolverhampton. I am glad to say that, by the assistance of the gentlemen who are thoroughly well acquainted with Wolverhampton, and who have given an immense deal of time to this matter, we have been able to secure an excellent site there, with good railway and canal communication, ample not only to provide for a very large extension of our business at the present moment, but also to provide for the future. Upon that site we intend immediately to erect works which will enable us to very largely increase our output at Wolverhampton. I am very glad to tell you, also, that in connection with the accumulator business of the Electrical Power Storage Company there is a steady growth, and when we are able to combine all the business, as we intend to do, in this office, and to have all our arrangements at headquarters, you will see that that will form a most valuable adjunct to the general business of the company. It is not very often, especially at this time of the year, that we get such a good attendance of shareholders at a statutory meeting, but we were rather anxious that our shareholders should meet us in our own offices on the first occasion, rather than that we should go to some hotel, and if the room is rather crowded perhaps you will excuse us. You will probably be aware that we are engaged at the present moment in supplying a very large quantity of plant to one of the most important companies that is supplying this metropolis. I think you will be interested to hear that Mr. Edison, who has just had an opportunity of visiting one of the installations with which we have had to do in this metropolis—namely, Rathbone Place—was pleased to say that it was the most satisfactory place he had seen during his visit here, and I am quite sure that the high character which our works director at Wolverhampton has secured to us by the excellent work he has been able to turn out, will be a most important factor in the success of this company, if only we can provide him with works large enough and with sufficient means to enable him to execute the orders which are pressing upon us on every side. Then, with reference to provincial questions, I do not think it would be wise—and I am sure the shareholders will agree with me in this—to mention names at the present time, because our business in that direction is somewhat in a preliminary stage. We are carrying on very active negotiations with several most important towns, both with reference to lighting, in which, I think, this company is going to fill a very important position, as being able not merely to provide these towns with light, but to help in the financial arrangements connected with lighting. I think that is where we are going to have a very important sphere of business; and then, not only with reference to lighting, but also with reference to the application of motors to tramways. We have got several very important matters before us, and we hope that before long we shall be able to show our shareholders a practical installation of this kind, where we shall be able to run the tramways by electricity in the very successful way in which they are being run so largely in the United States. We have applications both with reference to our Julien patents and to our Sprague patents. Then I may also say that with reference to the third point to which we attach importance —that of the installation for train lighting—a very excellent example has just been carried out by the Midland Railway Company upon the Stroudley-Houghton principle, and I believe that although it is only just started it is likely to be a very great success. The great difficulty which has arisen with reference to train installations has been how to replace the power, and I think the arrangements which are being made in connection with this train on the Midland are very likely to solve that difficulty. The great requirement for railway installations is that we should be able to light a train and be able to break it up. That has been done successfully on the Brighton Railway, but what we want is to light the train and be able to take a carriage off and shunt it on to a branch line. I don't know that I have anything more to say to you to-day, gentlemen. If there is any question any shareholder would like to ask I will endeavour to answer it to the best of my ability. Our difficulty at the present moment is simply this: that our works are quite insufficient to deal with the orders which we can secure at once, and therefore we are obliged to proceed rather cautiously; at the same time, I think we are laying the foundation of an excellent business. I may say we have secured here offices which will not be at all too large for our purpose, and we hope you will consider that they are in a good central position. And in connection with these offices we intend to have a thoroughly good arrangement in the base where our various manufactures will be placed, so that intending purchasers, and those in this city who intend to adopt electricity, will be able to come and see exactly what we are prepared to give them. It has been found very important to do this in connection with the Electrical Power Storage Company, from which we believe we shall secure a good deal of support. Before long we shall have a general meeting, and then we shall hope to present a regular report. In the meantime, I must ask you to be content with this very lame attempt to explain to you exactly how we stand.

A Shareholder: Do we understand that in regard to each branch of the undertaking the works are in full swing?

The Chairman: They are.

A Shareholder: And doing as much work as the accommodation permits of?

The Chairman: They are doing more work than we like to have to do in their present contracted condition. We are losing no time, however, in extending the works, which is the important thing.

Dr. Drysdale: Do you expect to have some tramways running in London?

The Chairman: Well, I cannot speak about London; I spoke about provincial towns. We have several provincial towns in which there are actual arrangements being made; I would rather not mention the names at the moment, but I have do doubt before very long you will know all about them.

Dr. Drysdale: Is there no chance of London?

The Chairman: I don't know; I think it is quite possible, but I cannot speak with certainty. We hope that before long we shall not only apply ourselves to the tractive question for tramways, but to a far more important question to my mind, and tbat is railways. I hope that electricity will be applied in the case of railways, and if we once begin I don't know where we shall end; but just now we are satisfied with the tramways.

Mr. Robert Chipperfield asked if it was true that the enormous demand far exceeded the power of supply, and, if so, how it was that four, at least, of the concerns they had purchased paid no dividends. If that was the case, was the sum of £400,000 or £500,000 not an enormous amount to be expended in establishing such a company as this, especially when they reflected that similar undertakings had more or less come to grief. He also wished to know on what basis the several purchase considerations were arrived at, and if the promotion money paid in purchasing the several undertakings amounted to something like £150,000. He believed the Elwell-Parker concern was the only one of the companies that paid a dividend. The prospectus stated that it paid a "substantial" dividend. It would be more satisfactory to know what the "substantial" dividend was. He wished, also, to know whether they had contracts for supplying light to the trains spoken of, or whether they simply obtained permission to make experiments, there being no contracts at all. He further asked what expenses they intended to incur in extending the works, and whether, when all the capital was called up, it would be sufficient to carry on all the business of the corporation for the present without calling up the remaining £50,000.

The Chairman said the amount of capital was £500,000, of which £50,000 was taken as part payment by those who had sold their businesses to the corporation; therefore, the actual amount issued to the public was £450,000, out of which they had called up £6 a share, and £4 a share was still uncalled, and remained as an asset to enable them to carry on their work, and to make all their payments. That amount of £500,000 left made a considerable balance for working capital. He sincerely trusted that it would not prove sufficient, or anything like sufficient, for what the corporation would have to do. His opinicn was that it was only the first instalment—if they succeeded as they expected to do—they would have to raise; but it was an ample amount for dealing with their present liabilities and providing them with working capital. There were certain questions of detail; for instance, the works at Wolverhampton, which he thought should be left over till the next ordinary meeting. They might be quite sure that the directors would be very careful not to expend money unless they thought it was going to produce a thoroughly good result. The present need of the company was extended works at Wolverhampton, and if they had them now they should be very lucky, because they could fill them with most profitable work immediately. He did not feel inclined to go into some of those questions which affected the original arrangements made, because all these matters were fairly put before the shareholders when the prospectus was issued. It was impossible for him to say what was paid for promotion money. What they did was to purchase the properties for a certain payment, and whether that payment included money to other people they had not the means of knowing. All he knew was the amount they were bound to pay to the vendor, Mr. Tarver, and that they meant to pay, and then he hoped they would be able to pay a good dividend on it in due course. He was told that Elwell-Parker paid dividends varying from 10 to 15 per cent.; and with reference to the other companies, he thought the point had been lost sight of by the gentlemen who had been speaking, that the great stepping-stone to success in this company was the amalgamation of these different interests. He did not think these companies standing by themselves would be worth what the corporation was paying for them; but the point was this: they were amalgamating those interests, and forming a strong buttress against opposition, and the patents which they held became extremely valuable.

Sir Daniel Cooper, Bart., said he had had to do with the railway lighting for the last five or six years, and he might state that all the contracts for lighting the different railways were written contracts. They had to give them 12 or 18 months at a certain price, so that the officials could judge for themselves whether the companies ought to take the lighting up or not. The officials wanted to be certain that they had got a good thing, and as the directors knew it was a good thing, they gave them all the facilities they could, and that was the only way he thought to promote the business of the company. He belonged to one of the companies whose business had been purchased by this corporation, and he knew they had got a good bargain. He did not see how, if the corporation was carried on with skill, and with a proper board of directors, it could fail to be a great success.

Mr. George Dibley then proposed a vote of thanks to the chairman for presiding.

Mr. Chipperfield seconded the motion, which was unanimously agreed to.

The Chairman having acknowledged the compliment, the proceedings terminated.

The Direct Spanish Telegraph Company, Limited.

THE thirty-second ordinary general meeting was held at Winchester House on Tuesday last, Sir James Anderson in the chair.

The Secretary having read the notice and the minutes of the last meeting,

The Chairman said: Gentlemen, I think, on the whole, you will consider that the report is a fairly satisfactory one. There is a decided increase in our traffic receipts of £508, and a slight decrease in working expenses. We had an interruption, as you know, of 16 days; but fortunately our connection with the Eastern Telegraph Company prevent interruptions being very serious. I am glad to say our revenue is mainly due to commerce; there are no political disturbances of any kind. We find, upon looking into the matter, that many towns now have a very free intercourse with Spain by telegraph; these towns never used the telegraph at all a few years ago, and therefore I suppose they had no trade with Spain. We are led to believe from this that the trade of this country is increasing with Spain, and this is a matter of congratulation to all of us, as well as to the prosperity of the nation itself. We have had telegrams from manufacturing towns which are quite new to us within the last two or three years. Last month we carried 290 more telegrams, consisting of 33,000 words in excess of September last year. For the last quarter, July to September, our receipts were £381 more than last year, notwithstanding our low tariff, which is, as you know, 4½d. per word. We deliver messages in Bilbao under 10 minutes, sometimes in 5 minutes; to Madrid within three-quarters of an hour, and we hope to improve upon that. Our telegraph service depends first upon accuracy, and then speed, and that speed is developed by having better wires for Bilbao and Madrid. We have very little to complain of, but still there is room for a little improvement. We have still to count with the reduction of the length of messages. I scarcely know where it is going to stop. Last year, though we carried more messages, we made less money; however, we have got over that stage this year; we have made more money, and carried more messages. The only thing I have to call your attention to in the way of expenditure is that we have shifted our office from Leadenhall Street to Gracechurch Street. The business had increased so much, that it was impossible to do it satisfactorily in our old premises. The whole of this has cost £600; that, however, we propose to take off the revenue gradually. That is about all I have to refer to; it is a very simple report, though, I think, a short report and a big dividend are the best things we can have.

A few questions were put to the chairman, which were answered, and the report was then adopted. A dividend of 10 per cent. on the preference, and 5 per cent. on the ordinary shares was then proposed and adopted.

A vote of thanks to the chairman brought the proceedings to a close.

TRAFFIC RECEIPTS

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts for the month of September were £3,400 as compared with £2,774 in the corresponding month of last year. The receipts for the month of June, estimated at £3,300, realised £3,297.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of September were £2,189, against £1,886 in the corresponding period of last year.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 30th September, are £2,306 as compared with £2,060 in the corresponding period of 1888. The June receipts estimated at £5,907 realised £5,906.

ELECTRIC LIGHTING IN LONDON.

WORKS APPROVED BY THE COUNTY COUNCIL.

THE first meeting after the recess of the London County Council was held last Tuesday at the Guildhall (Lord Rosebery in the chair), when an important report of the Highways Committee, dealing chiefly with electric lighting operations in London, was presented by Mr. A. H. Haggis. The first part of the report was as under:—

"Your committee have considered the following notices, given to the Council, of works under electric lighting orders, together with reports by the engineer and the solicitor thereon—

"(*a*) August 27th, 1889, from the House-to-House Electric Light Supply Company, Limited, of intention to lay mains for the supply of electricity in the parish of Kensington, as shown on plan sent with letter.

"(*b*) 2nd and 6th September, respectively, from the Kensington and Knightsbridge Electric Lighting Company, of intention to lay mains in certain thoroughfares in Knightsbridge and Kensington.

"(*c*) 4th September, 1889, from the London Electric Supply Corporation, of intention to lay a distributing main under the footway on the south side of the Strand, from the eastern boundary of the parish of St. Martin-in-the-Fields to the north-east corner of Northumberland Avenue.

"(*d*) 4th September, 1889, from the same company, of intention to lay distributing mains under the footways on each side of Victoria Street, Westminster.

"(*e*) 5th September, 1889, from the Metropolitan Electric Supply Company, Limited, of intention to lay mains and distributing boxes in certain thoroughfares marked on five plans sent with the notice.

"(*f*) 9th September, 1889, from the Chelsea Electricity Supply Company, Limited, of intention to commence works for distribution of electricity in a portion of the parish of Kensington, shown in red colour upon the map sent with the letter, and forwarding a description of the proposed works.

"(*a*) It is necessary that the approval or disapproval of the Council to the proposed works shall in each case be signified within one calendar month of the receipt of the notice; and your committee, acting upon the authority given to them by the Council on the 2nd of August, have, in the case of the House-to-House Electric Light Supply Company's notice, which expires on the 30th inst., assented on behalf of the Council to the proposed works, subject to the condition that the covers of the surface-boxes shall consist of iron frames filled in with stone or other suitable material, and shall be in all respects subject to the approval of the engineer of the Council, and that the mains shall be laid under the footways, except when the engineer of the Council shall consider it impracticable so to do. Your committee now ask the Council to ratify the course taken.

"(*b*) The works referred to in the Kensington and Knightsbridge Electric Lighting Company's notice are, in the opinion of your committee, open to some objections, the principal being the large size of the distributing boxes which the company proposes to adopt, and your committee have instructed the engineer to confer with the company's officers with a view to some modifications being agreed upon. In the meantime, as the first notice will expire on the 2nd of October, your committee recommend—

"That notice be given to the Kensington and Knightsbridge Electric Lighting Company of the Council's disapproval of the works referred to in the company's notices dated 2nd and 6th September, 1889, respectively.

"(*c* and *d*) The works referred to in the notices of the London Electric Supply Corporation appear to be unobjectionable, and your committee recommend :—

"That the Council do approve such works, subject to the condition that the mains crossing the carriage-way of side streets be laid under the concrete.

"(*e*) The Metropolitan Electric Supply Company's notice refers to works over a large area, and the information supplied is insufficient. Your committee have, however, ascertained that the company wishes to commence at once the works shown on three plans, marked respectively No. 1, No. 2, and No. 3, with respect to which works full information has been supplied. To these works your committee see no objection, and they accordingly recommend :—

"That the Council do approve of so much of the works referred to in the notice as are shown upon the plans marked No. 1, No. 2, and No. 3, and signed by the chairman of the committee, upon condition that the mains shall be laid, wherever practicable, under the footways, and that the covers of the testing boxes shall consist of iron frames filled in with stone, or other material, to suit the paving.

"(*f*) With reference to the Chelsea Electricity Supply Company's notice, it appears to your committee that there is no objection to the proposed works, except that the company proposes to use cast-iron covers for the numerous distributing and other boxes. Your committee think that these would be a source of danger to pedestrians in slippery weather, and that the covers of the boxes should consist of iron frames filled in with York stone, cement, or other material. They therefore recommend :—

"That the Council do approve of the works specified in the notice of the Chelsea Eleqtricity Supply Company, subject to the condition that the covers of the distributing and other boxes shall consist of iron frames filled in with stone or other material to suit the paving, and that the mains shall be laid, wherever practicable, under the footways."

On the motion of Mr. Haggis, the Council approved of the recommendations of the committee.

The committee further reported that they had considered a letter from Messrs. L. Clark, Muirhead & Co., on behalf of the St. James's and Pall Mall Electric Light Company, stating that under the powers conferred by the licence granted to the company in 1888, it intended to lay mains and distributing boxes in certain streets in the parish of St. James's, Westminster, as shown upon a plan submitted with the letter. The committee had received a report from the engineer on this application, who saw no objection to the proposed works ; and they recommended :—

"That the consent of the Council be given to the laying of the St. James's and Pall Mall Electric Light Company's mains in the streets specified in the letter from Messrs. Latimer Clark, Muirhead & Co., upon condition that the work be carried out to the satisfaction of the proper authorities."

The recommendation was approved.

ELECTRIC LIGHTING IN THE CITY.

Discussion at the Commissioners of Sewers.

On Tuesday last in accordance with a requisition of a number of the members, a specially convened court of the City Commissioners of Sewers was held at the Guildhall (Mr. George Manners in the chair) to consider the following resolution (by Mr. H. H. Bridgman) and amendment (by Mr. J. E. Sly) on the subject of electric lighting :—

"That the abstract of tenders for electric lighting be printed and circulated for the information of the Commissioners."

"That the report of the Streets Committee of July 30th on electric lighting, and the abstract of tenders be printed and circulated among the members of the commission."

Mr. Bridgman stated that he had put the notice of motion on the agenda paper in order to get out of the deadlock of last week, as he understood that then the chairman said he could not put a motion for the printing of the report on electric lighting. If the chairman had now altered his mind and would allow of such a motion he (Mr. Bridgman) would withdraw in favour of Mr. Sly.

The Chairman : I have not altered my mind. What I said, and say still, is that it was out of order to discuss the question of electric lighting on that day.

Mr. Bridgman : I am in accord with Mr. Sly's motion, and I ask the court to allow me to withdraw my motion in favour of his.

The Chairman : You have a perfect right to ask that. What, however, we have before us is on the agenda paper, and both of the resolutions are in order.

Mr. Bridgman then proposed the resolution in his name given above.

Mr. Rose Innes, who seconded the resolution, said he should like to point out how convenient it would be to the court if, when the report was printed, they were made aware of what was the state of affairs when the City was previously lighted by electricity —of what the tenders were, who were the contractors, what prices were tendered, and the sum actually paid. For the purposes of discussion it would be most convenient for every Commissioner to have that information in his hand.

Mr. Sly observed that at the last meeting of the court he intervened to get the Commission out of a difficulty, his object being that they might have a proper report and information, so as to enable them to properly discuss the important question. He was desirous that they should have all possible information before them when the report came on for discussion. He then moved the amendment of which he had given notice.

The amendment having been seconded,

Mr. Pannell said he had been very closely connected with the electric lighting question whilst it was being discussed in committee. He did not think it would be of any advantage to them to go back to the original contracts under which the City was more or less sufficiently and efficiently lighted, unless they followed up the history of electric lighting from that date to the present. There had been a number of reports founded on the efficacy or non-efficacy of the electric light. It would be no advantage to the Commission unless they made the history complete up to the present date. In fact, it would otherwise be rather misleading, because a good deal that which was only theory in the past had now been proved by practice. They had better pass Mr. Sly's amendment and then they could at any momont call for all the documents Mr. Innes desired. The history of the electric light in the City filled a good number of books, and most of the reports which had been made were based upon the original contracts.

A Member complained that there had already been quite sufficient delay. The Streets Committee had had a good many meetings, and given much time to the subject. He had urged the engineer to do his utmost to bring the matter forward so as to have a report before the vacation, and he did his best. Mr. Preece had also been very zealous in the matter, and had done his utmost ; but when he (the speaker) proposed that the report should be printed it was objected to. It would have been very convenient if it had been printed two months ago, so that the members of the Court might have studied it during the vacation. They would have been in a much better position than now. Under the circumstances the best thing the Court could do was to vote for Mr. Sly's amendment.

The amendment having been carried, it was submitted as a substantive motion, whereupon

Mr. Pannell asked permission to put a question. He wanted the Court to have as full information as possible, otherwise the printing of the report would be of little use. He wanted to ask the engineer whether in his opinion the printing of the report, and of the abstracts of the contracts, would, by themselves, give the Commission the fullest information, or whether he thought that any remarks of his (the engineer's), or of Mr. Preece, which had been before the committee, ought not to be included in that circulated among the Commission, because, if so, he (Mr. Pannell) was prepared to move that that be done.

Col. Haywood (the engineer) replied that he did not consider that the report would give all the information desirable. In nearly all the tenders sent in by the companies there were some modifications. They did not strictly agree with the conditions which the committee had drawn up ; but the companies were willing to agree to the conditions under this or that modification. The company which had most nearly agreed with them was the Brush, with whom they had negotiated about a year and a half previously ; and the conditions agreed to by that company were mainly those which went out to public tender. But since then the matter had been referred to Mr. Preece and himself (Col. Haywood) to see if they could not induce the two principal companies besides the Brush to agree to terms practically the same, or as nearly as possible similar, to those accepted by the Brush. The report would not give the result of the amended views of the company, and he thought that it was desirable on that matter to let the Commission know in some way or other exactly what the companies would or would not do at the present time.

Mr. Pannell thought that after what they had just heard the Commission would see that his question had elicited some useful information, most desirable at the present moment. He could not move an amendment, but he hoped some member would do so, in order that they might include the obtaining of the additional information their engineer had shown them was requisite.

Mr. Rose Innes said it need not be feared that he desired to place any obstruction in the way of obtaining the electric light. The information he referred to as being desirable was scattered about through a series of reports and cash accounts, and it would take the commissioners a long time to make themselves masters of all the points. As a result, when they came to debate the question of the tenders they would be interrupted and delayed by applications for further information. The Commission ought to have before it the exact cost at which the City was previously lighted by electricity, and also the exact districts which were lighted by Messrs. Siemens and the Brush Company; how long the lighting continued, and when the lighting ceased. Whilst they were printing the report they might just as well have that additional information in their hands. He thought the Commission would agree with his amendment, which was: "That in addition the engineer be requested to supply the names of the companies which lighted the City experimentally some years since, the districts lighted, the cost of that lighting and when the lighting ceased."

Col. **Haywood**: That has practically passed out of my hands.

Mr. **Sly**: On a point of order. The hon. member having seconded a motion just now, is not in order in proposing an amendment.

The **Chairman**: Mr. Innes is in order.

Mr. **Williamson** seconded the amendment, and urged that the engineer should be empowered to submit any further information he possessed which would be of use to the Commission. The sooner they had in their hands all possible information in connection with the subject of electric lighting in the City in the past the sooner they would be able to come to a definite conclusion and to make a definite move in the matter.

Mr. **Pannell** did not see the practical outcome of the amendment. The electric lighting of the past, no matter what its cost or its want of efficiency, was now a thing of the past. It was now some years ago, and they did not want to trammel their present action and to trail something across their path from time to time by having a history of electric lighting from the time that it was a failure up to the present when it was more or less a commercial success. If Mr. Innes wanted the information about certain tenders he should direct the clerk——

Mr. **Innes**: And the cost and districts.

Mr. **Pannell** said that they would find that the present price was materially reduced. They ought to have a more practical resolution to the effect that the engineer and Mr. Preece be instructed to prepare and add to whatever the printed matter might be that the commission decided upon, their report on the negotiations which, on the instructions of the Streets Committee, they had carried on with certain other companies so as to ascertain how far those possibly competing companies could be brought to approach the commission on something like parallel lines to those already agreed to by the Brush Company. Such information would be most important.

A **Member**: That is the very information the engineer offered to us.

Mr. **Pannell**: No; the engineer did not offer it to us. He said he thought we ought to have such additional information.

Mr. **Sly**: I am perfectly willing to accept the suggestion made by the engineer. All I want is to obtain the fullest information.

Mr. **Bridgman** thought they would be adding confusion to the Streets Committee's report. The printing and circulating of the report was a simple matter; but if they were to add the expected cost, and the time, and the districts, others might want other information, and then the commission would not take the trouble to read it all. It would not help them in the solution of the question. With the assistance given by the engineer and Mr. Preece they had everything that was necessary. He hoped the report would be read before the members attended again. It seemed to some outside as if they were a parcel of children trying to deal with the matter. (Cries of "oh, oh.") Yes; the people outside were saying so.

The amendment having been submitted to the court and lost,

Mr. **Pannell** proposed as a further amendment, the addition of the following to Mr. Sly's proposal:—"That in addition, the engineer and Mr. Preece be requested to amend the abstract of tenders so as to make them in conformity with the conditions under which the various companies are now prepared to contract."

Mr. **Sly**: I accept that.

The amendment of Mr. Sly, with the above additional words, was seconded by Mr. Deputy Bedford, and agreed to as a substantive motion, and the Court adjourned.

THE EDINBURGH ELECTRICAL EXHIBITION.

The Executive Committee of the Edinburgh Electrical Exhibition have just completed their arrangements, and the prospectus will be issued in a day or two. Her Majesty the Queen has given her patronage to the exhibition, and among the nobility who have already agreed to act as patrons may be mentioned: the Duke of Buccleuch, Duke of Sutherland, Earl of Aberdeen, Earl of Rosebery, Earl of Elgin, Earl of Kinnoul, Marquis of Bredalbane, Marquis of Tweeddale, Earl of Stair, and Lord Rosslyn. The Marquis of Lothian, Secretary of State for Scotland, has been appointed president, and amongst the vice-presidents is Mr. Edison. The exhibition will be under the general management of Mr. S. Lee Bapty, general manager of the Manchester Exhibition of 1887.

In their prospectus the committee state that as the Forth Bridge, the greatest engineering work which the world has known, is expected to be opened for passenger traffic in the spring of 1890, it has been considered that such an important event would be fittingly celebrated by the holding of an International Exhibition in the City of Edinburgh, specially devoted to electrical and general inventions and industries. Edinburgh has always been a favourite place of resort for tourists, and with the additional attraction of the opening of the Forth Bridge, the year 1890 may well be looked forward to for largely increased numbers, which must tend to augment the normal attendance at the exhibition. All the electrical exhibitions hitherto held have been very popular, and more than realised the expectations of their promoters; and as there has been no important exhibition of this character in Scotland, it is believed that this exhibition will meet with equal success. A special feature will be the provision of a Lecture Hall, in which, during the progress of the exhibition, a course of popular lectures will be delivered explanatory of the principles, construction, and objects of the chief exhibits. This hall will serve likewise for the special meetings of the Institution of Electrical Engineers, the Société Internationale des Electriciens, and other scientific bodies, which, it is hoped and expected, will be arranged for in connection with the exhibition. A guarantee fund has been initiated, and has already received a large and encouraging measure of support. The international character of the exhibition will receive special attention; and from the promises of co-operation already received from many important foreign bodies and individual exhibitors, it is certain that this department will be of exceptional interest. As it is intended that the exhibition shall be complete and perfect on the opening day, exhibitors are requested to forward their application forms at the earliest possible moment, in order that any extra accommodation which may be required may be provided in good time.

The exhibits are classified into two divisions—(1) Electrical engineering and inventions; and (2) General inventions and industries.

Under the first division there are six sections as follows:—

Section I.—Production of electricity embracing class 1; apparatus for electricity of high electromotive force; class 2, voltaic-electric apparatus; class 3, thermo-electrical apparatus; class 4, magneto-electric apparatus; and class 5, dynamo-electric apparatus.

Section II.—Electrical conductors, embracing class 6, telegraph wires; class 7, telephone wires and cables; class 8, electric light circuits; class 9, underground conduits; class 10, submarine cables; class 11, insulating materials; class 12, electrical joints and connections.

Section III.—Measurements, embracing class 13, measurements of dimensions; class 14, measurements of speed, force and energy; class 15, electrical measurements, resistance, electromotive force, current, capacity, &c.; and class 16, photometric measurements.

Section IV.—Applications of electricity, embracing class 17, electric telegraph; class 18, apparatus for transmission of sound; class 19, fire and burglars' alarms; class 20, annunciators; class 21, electric clocks and time telegraphs; class 22, electrical registering apparatus; class 23, electrical signal apparatus; class 24, electrical, medical and surgical apparatus; class 25, electro-motors and their applications to trades and industries; class 26, application of electricity to warfare; class 27, application of electricity to writing and printing and musical instruments; class 28, electric lighting; class 29, electro-chemistry and electro-metallurgy; class 30, storage batteries and accumulators; class 31, miscellaneous applications.

Section V.—Class 32, bibliographic collection of works relating to electricity, plans, drawings, &c.

Section VI.—Class 33, historical collection.

INTERNATIONAL CONGRESS OF ELECTRICIANS HELD AT PARIS, 1889.

(*Concluded from page* 369.)

ELECTRO-PHYSIOLOGY.

Report of M. D'ARSONVAL,

Member of the Academy of Medicine, Assistant Professor at the College de France.

THE part played in therapeutics by physical agents (heat, electricity, pressure, cold, &c.) becomes daily more important, and with reason. The employment of physical agents is not complicated by any indirect effect; the action can be graduated at will, and the application repeated without the slightest inconvenience. Modern physiology has proved that of all the physical excitants electricity is the simplest and most efficacious for bringing into play the properties of the nerves and muscles.

Moreover, the recent progress made in electrical science has shown that no force known at the present day is more easy to control and measure out rigorously than the electrical agent. The progress in industry has familiarised a large proportion of the enlightened public with notions of general physics that still remain a dead letter to that part of the medical world which treats physics and chemistry as sciences accessory to medicine.

However, a large number of practitioners now employ electricity successfully, but for their observations to be of any utility in the advancement of science, for the facts which they advance to be repeated and controlled, it is above all necessary that they should know precisely the physical conditions under which they are working. To do this doctors employing electricity must learn the language, so accurate and yet so simple, of electricians, and not allow of arbitrary measurements when they take the trouble to make any at all. The Congress of 1881 has already made an important advance by rendering obligatory in electro-therapeutics the employment of the volt and the milliampère for the measurement of the continuous current, in accordance with the proposal of M. d'Arsonval and M. Marey. To arrive at this result it was sufficient to borrow from electricians their methods and their instruments, slightly modifying the latter in order to adapt them to this new use. But the electrical agent is not employed in physiology and medicine solely under the form of the continuous current; we might even say that this mode of application is exceptional. It only addresses itself to one of the two great aspects of life—*nutrition.* When, on the contrary, it is required to bring the functions into play it is to the interrupted current, the electric shock, that we must resort.

In this second case the problem becomes much more complicated from the point of view of measurement, for physiologists cannot in this case obtain much help from electricians. The nerves and muscles answer to the electric excitant by reactions that are peculiar to themselves. Moreover, unlike that which takes place with inanimate receivers, the nature of the excitation will completely modify the excitability of the living receiver, if this excitation does not fulfil certain physical conditions, the knowledge of which belongs exclusively to the domain of the physiologist. In order to apply electricity successfully to the healing art, one must be both physiologist and electrician; physiologist, in order to know the fundamental properties of the living material; electrician, in order to appreciate accurately the physical qualities of the excitant employed. Living beings are not only sensible to electricity, but, what is more, they produce it on their own account, and by means proper to themselves, as they produce heat, light, synthesis, mechanical work, &c. This *modus faciendi*, which differs from the operations of the chemist and physicist, establishes a broad line of demarcation between inorganic physics and biological physics, a complete science of more recent date.

Lastly, the industrial applications of electricity have rendered this force a power very formidable at times, the effects of which, resembling those of lightning, have caused accidents, the study of which is of the greatest interest, both to the physiologist and the doctor.

These various considerations have led us to think that it would be interesting to direct the discussions of the Congress to the three followings points:—

1. The comparison of the effects obtained by the employment of various medical apparatus. The necessity of defining the currents employed.
2. The nature of the electrical phenomena produced in living beings.
3. The effects upon human beings of the discharges, continuous currents, and alternating currents employed in industry.

And as a corollary:

4. The precautions to be taken in electric installations.

We will briefly review these four points.

Comparison of Medical Apparatus.

A. *Continuous Current Apparatus.*—This first point has been solved by the Congress of 1881, when the use of it was laid down in practical units derived from the C.G.S. system, viz., the volt for the potential or tension, the milliampère for the current strength. It would be desirable to add to these two indications the nature of the electrodes and their surface of contact with the tissues, *i.e.*, the density of the current per square centimetre. This indication is generally useless in physiology, where the surface excited is reduced to a point.

B. *Apparatus with Interrupted Current or Apparatus for giving Shocks.*—These apparatus are employed mainly for working upon the nerves and muscles. Let us first see what is the fundamental law of the electric excitability of these organs.

A *constant current*, generated by one or two Daniell elements, for example, applied to the nerve or directly to the muscle, provoked a sharp contraction (shock) every time it is established or suppressed (opening or closing shocks). If, by means of a metallic resistance, the current is made to pass slowly from zero to its maximum, the muscle remains at rest; but, on the contrary, it contracts if a *sudden* variation in the current is produced. The greater the suddenness of this variation the more powerful is the shock. In a word, the nerve and the muscle are excited by the *variable condition* and not by the permanent action of the current within the limits already indicated.

The intensity of the muscular contraction is not necessarily in proportion to the *energy* of the discharge of a standard condenser.

A physiological excitation is not defined when we know the *fall of potential* and the *quantity* of electricity set in motion. We must also know the *time* of the fall and the *phases* of the fall, *all else being equal.* The curve thus obtained constitutes the *characteristic of excitation* (d'Arsonval).

By reducing the discharge to an *infinitely short* space of time we should evidently only have to take into account the *quantity* of electricity set in motion. We may consider this condition realised *in practice* by the discharges of the condenser and the induced current of rupture of induction coils. This condition of *instantaneity of the electric flow* of discharge is only realised in the case of the condenser, on the express condition that this apparatus is discharged into a conductor of comparatively low resistance. It is therefore useless, in exact experiments, to try to excite *directly* by the discharge of a standard condenser (microfarad) a body as resisting as the nervous tissue. We may, without producing the least contraction, discharge a Leyden jar upon a nerve or a muscle if we slacken the discharge by means of a piece of cotton. It is therefore preferable to send the discharge of the condenser into the primary wire of an induction coil; we thus get the induced currents always equal and not direct (d'Arsonval, 1881). As to the induced current of rupture, it may be easily graduated in coulombs by sending the discharge through a ballistic galvanometer and comparing the discharge with that from a standard condenser, as I described to the Biological Society in 1884. The difficulty consists in having a vibrator giving exactly similar ruptures, especially in the case of frequent interruptions. It is, in my opinion, absolutely useless to have more than 50 interruptions per second, this frequency being quite sufficient to bring about the tetanus of the muscle by the continuity of the shocks. As to the induction coil, the only model giving a regular graduation of the induced current is the Siemens and Halske apparatus with movable helices, better known under the name of Du Bois-Reymond, the use of which was long ago introduced into electro-therapeutics by A. Tripier.

From the point of view of numerical graduation this apparatus has the inconvenience of not offering a simple relation between the intensity of the induced coil and the distance between the bobbins; moreover, it is cumbersome when very sensitive nerves are excited. In certain cases of excitation of the diaphragmatic nerve we (M. Brown-Séquard and myself) have been obliged to place the two bobbins of the Gaiffe apparatus more than 1·4 metres apart from one another. I had graduated our apparatus in coulombs by the ballistic galvanometer. In delicate experiments we could, as I proposed, with advantage substitute for this apparatus two concentric circular bobbins, the planes of which might gradually be rendered perpendicular to one another by a continuous rotatory movement. The intensity of the induced coil would thus be in proportion to the cosine of the angle formed by the two planes. A third mode of graduating the induced current would consist in graduating the inducting current by the interposition of resistances in the circuit of the primary wire, weakening the current of the battery in certain fixed proportions. This method is the least perfect of the three, as it changes the variation of the inducting current, and, consequently, the duration of the induced current. Static electricity may be measured in the same manner by the galvanometer, when it is employed under the form of a continuous flow. The intensity of the flow given by a good Holtz machine with four plates, has never exceeded $\frac{1}{10000000}$th of an ampère in my experiments. As to the shocks, they are always produced under the same conditions, by employing a Lane electrometric jar of known capacity. To graduate the intensity with regularity, it is sufficient to discharge the jar into the primary wire of an induction coil with movable helices.

It is much more difficult to measure out the currents from magneto-faradic apparatus, for their intensity depends upon a number of variable conditions (speed of rotation, the more or less powerful magnetisation of the magnet, distance of the induced bobbin from this magnet, &c.).

To sum up briefly the subject of the graduation of faradic apparatus, it would be sufficient, *in practice*, to indicate the value of the induced current of rupture in micro-coulombs, corresponding to each separation of the movable helices for a determined value of the inductive current. These two indications may easily be given by the constructor.* The electromotive force of the induced current varies according to the quantity of electricity itself, since the time of induction remains constant. Consequently the energy of the induced current varies as the square of the quantity of electricity set in action. It is then sufficient to indicate the value for a single point of the graduation.

Nature of the Electric Phenomena produced in Living Beings.

All living beings are the seat of electrical manifestations. Electricity of animal origin has been specially studied in two tissues—the nerves and the muscles. It is nevertheless certain that its production is much more general, and that it accompanies all manifestations of vitality. Electro-genesis must be, like thermo-genesis, a cellular phenomenon springing from the same cause: the correlative respiratory combustions of life.

The living tissues give rise to two sorts of electrical manifestations, which do not seem to spring from the same sources of production.

We must distinguish:

1. *Continuous* electrical manifestations, which are also termed currents of rest;

2. From *intermittent* electrical manifestations, or currents of action.

The currents of action are remarkable in that they act as veritable discharges, attaining, in certain cases (electrical fish), considerable intensities. Moreover, these currents do not seem to pre-exist in the tissues that form their seat, but to come into existence at the moment when the organ enters upon its function.

The laws which govern the production of the continuous currents have been carefully studied in the nerves and muscles *separated from the body*. In order to study these currents, special instruments must be employed (impolarisable electrodes, aperiodic galvanometers, or the Lippmann electrometer).

We do not know yet for certain whether these currents of rest pre-exist or whether they are the result of accident (such as the wounding of the muscles). Experiment shows clearly that *the surface of a muscle absolutely intact does not show electrical tension*, or only extremely feeble tension.

All that we can say is, that the electrical manifestations in the muscles and nerves when separated from the organism are extremely regular, and *are certainly connected with the chemical and physical constitution of the contractile substance*. On this score they possess great physiological interest.

These differences of tension, maintained with closed circuit at the surface of the muscle, are caused by chemical actions. This assertion is evidently only a mode of expressing the law of the conservation of energy, but it is based upon the following experience:—

1. The differences of tension decrease in the isolated muscle with its excitability; when this latter has disappeared, all trace of a regular current has also disappeared;

2. This current is weakened and made to disappear momentarily by deadening the muscle by means of ether, *i.e.*, by hindering the chemical functions of the protoplasm.

All the *continuous* electrical manifestations of living matter are, in our opinion, far from being traceable to chemical action as their *immediate* cause. Continuous currents may be obtained by means of purely physical phenomena, which find their conditions of existence in the organism:

1. By the simple filtration of a liquid without chemical action, through a porous septum, the reverse, in short, of Porrett's phenomenon;

2. The flowing of a liquid through a tube;

3. The phenomena stated by M. Becquerel *père* under the name of electro-capillary currents, &c. Much more interesting are the intermittent electrical manifestations of which the living tissues are the seat.

If we excite a muscle by any irritant whatever, we find:

1. *That every excited point becomes negative in relation to the muscular substance not excited;*

2. *That the rate of propagation of this negative wave is the same as that of the propagation of the muscular wave* (about 3 metres per second for the *curaisé* muscle of a frog);

3. That this negative wave lasts as long as the contractile wave.

4. That the electromotive force of the negative wave or of the active current may attain to the value of that of the current of rest (·1 Daniell) which it never exceeds.

This active current (called also, but erroneously, the *negative oscillation* or *variation*) is sufficiently intense to excite a nerve or even a muscle in which it is derived (Matteucci's induced contraction). The laws of the current of action in the nerve are based upon those of the muscle, only the electromotive force of these currents is weaker than for the muscle (·02 to ·03 Daniells in mammifers).

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* M. Gaiffe, *fils*, in France, has already taken up this idea, and sends out apparatus bearing the two graduations.

The currents of action cannot be supposed to be the result of preparation, for they may easily be observed in man and mammifers at each beat of the heart by employing the apparatus indicated by Dr. Augustus Waller (1888). These currents attain an extraordinary intensity in the discharge of the electrical organ of certain fish (the torpedo, gymnotus, silure, &c.). Electricity is not pre-existent in these organs; they cannot be likened either to a condenser or to a battery, since, when in a state of rest they manifest no external electrical tension betokening a charge comparable to the energy of the discharge. Therefore these organs produce electricity only at the moment when they enter upon their function under the influence of the will of the animal. They act, from the point of view of the production of electrical energy, exactly as the muscle acts with regard to mechanical energy, as shown by the fine analysis made by M. Marey. The nervous system no more makes the electricity in the electrical organ than it makes the mechanical force in the muscle, since discharges are obtained after the organ is separated from the nervous centres, as with the muscle.

If contractibility is the property of the muscle electricity (to use a corresponding expression) is by the same reasoning the property of the electrical organ.

What is the origin of these currents of action? No satisfactory theory has as yet been advanced. We find ourselves met by hypotheses more or less ingenious giving us molecular groupings, which are more or less fanciful, and the arrangement of which is changed according to the necessities of the case. M. d'Arsonval has attempted an explanation, resting upon a physical basis, into which enter the remarkable laws discovered by M. Lippmann, which establish a relation between capilliary phenomena and electrical phenomena in the inorganic world. M. d'Arsonval has shown that a relation of this kind exists between the animal electricity and the superficial tension. All the phenomena known at present bear out this explanation.

Effects of Discharges, Continuous Currents and Alternating Currents on Animals.—Electrolysis of the Tissues.—Precautions to be taken.

Direct experiments have been made upon different animals (rabbits, guinea pigs and dogs) by means of the following sources of electricity:—

1. A static machine (Holtz, with 4 plates) charging a battery of 9 large jars;
2. A battery of 420 volts;
3. Continuous current Gramme machines of from 110 volts to 8,000 volts;
4. Alternating current Gramme machines (300 volts mean potential);
5. Induction coils and extra currents, worked by accumulators.

These experiments led the author to formulate the following conclusions (d'Arsonval, *Académie des Sciences*, April 4th, 1887):—

According to what has already been said, living beings are especially sensitive to the variable condition of the current; this amounts to saying at once that with an equal mean potential alternating currents are much more dangerous than a continuous current.

The very varied effects of electricity upon living beings may be divided into two special categories, which comprise them all. Electricity causes death in the two following ways:—

1. *By direct action* (the disruptive effects of the discharge, which act mechanically by destroying the tissues);

2. *By reflex or indirect action* (by acting upon the nervous centres, the irritation of which causes the infinite variety of injurious actions known since the researches of M. Brown Séquard under the names of *inhibition* and *dynamogénie*).

The static discharge is only fatal when it strikes directly the bulbe ractüdien, *i.e.*, the respiratory centre, with well localised discharges, the energy of which corresponds to about 3 kilogrammetres.

A. Under these conditions the different tissues (nerves, blood, muscles), when struck singly by the discharge, lose their physiological properties without possible recovery.

B. With a battery of 420 volts death is only caused by interruptions repeated for a long time. This death is due to the state of tetanus provoked by the current, and is accompanied by a considerable elevation of temperature, which is the true cause of death.

C. The continuous current Gramme machine is only dangerous (at 110 volts) through its extra current of breakage. The compound wound machines are less deadly in their effects with an equal potential, for the second winding serves as a derivation at the moment of rupture.

With a machine of 8,000 volts a momentary closing of the current caused the animal (a rabbit) to make a prodigious leap, but did not cause death immediately; a second application was necessary. (Unpublished experiment made in 1888 at the works of the Gramme Company.)

D. An alternating Gramme machine only causes death above 120 volts mean potential.

E. An extra current bobbin (thick wire) is more dangerous than an induction coil, especially if it is associated with a condenser. The danger of a single discharge is defined only by the electric curve of this discharge. The knowledge of the difference of potential and the mean intensity is not sufficient; it is generally necessary to take into account, all things else being equal, the duration of this discharge. With equal energy the danger is in inverse proportion to this duration. It is the same with alternating currents, in which case we must also take into account the number of inversions per second.

The grouping into two classes of the effects produced by electricity at a high potential is of great practical value, in this sense, that in the first case death is certain and definite (destruction with laceration of the tissues), whereas in the second (death by irritation without destruction of the nervous centres), the individual may possibly be restored to life by performing artificial respiration immediately after the accident. The continuous current of feeble intensity, applied to the nerves, brings about in these latter a modification of their excitability, known by the name of *electrotonus*, into the details of which we cannot enter here. This modification seems traceable solely to the polarisation produced by the passage of the current between the cylindrical axis of the nerve and the myéline, for it is absent, or, at any rate, very feeble in the nerves that are destitute of myéline. The passage of the continuous current into all the tissues of the organism, for practical intensities varying from 10 to 250 milliampéres, is accompanied by electrolytic phenomena utilised surgically by Cunselli, of Cremona, for destroying the tissues without loss of blood. This valuable method, introduced into France by Tripier, seems capable of giving excellent results in skilful hands. The passage of the current in this case acts as a local caustic by depositing acids at the positive pole, and bases at the negative pole, in a nascent condition. In a word, electricity serves to introduce an acid or alkaline caustic, localising the caustic action at the level of the poles. The positive polar cauterisation gives rise to hard, retractile scars; the contrary would be the case with the negative polar cauterisation, according to Tripier. We have thus two very distinct therapeutic indications.

It remains for us to determine experimentally what are the intensities which it is useless or dangerous to exceed, for the continuous current may entail, whilst exciting, general disorder, when its intensity, *i.e.*, its density at certain points attains to a value exceeding 1 ampère.

REPORT OF THE POST AND TELEGRAPH DEPARTMENT OF QUEENSLAND FOR 1888.

The report for 1888, of the Superintendent of Electric Telegraphs, Mr. A. F. Matveieff, concerning the Telegraph Branch, shows that in Queensland there are now over 9,202¼ miles of line, and 16,684½ miles of wire open for public business. At the close of 1888 there were 311 stations in daily operation, and 683 officers employed, including those holding appointments in other departments, but exclusive of assistants at country stations (officers' wives) and construction parties.

In the Southern and South-Western districts all the lines have worked well, the insulation being unusually good, owing no doubt in some measure to the dry weather which has prevailed, but much of the improvement on some circuits is to be attributed to the removal by maintenance parties of old defects. While the absence of wet weather has been an advantage on the one hand, yet the drought on the other has allowed very disastrous bush fires to range over large tracts of country, causing damage to the lines and numerous breaks which took a long time to repair. They were most frequent from August to December, but have been troublesome throughout the whole year. The interruptions caused by them have been most numerous, longest in duration, and by far the most costly to repair, owing to the number of poles destroyed. On the 18th September 19 poles were burnt between Roma and Mitchell; on the 10th October 26 were destroyed between Tambo and Blackall, and on the 27th of the same month no less than 40 poles shared the same fate between Eulo and Thargomindah. Bush fires also caused extensive damage to the wires over nine miles of country on the 19th and 20th of October between Hawkwood and Camboon, and on the 28th October over several miles of the line between Augathella and Tambo. In some cases the wire on falling to the ground was fused into short lengths by the intense heat, and where iron poles were in use they became red hot and cracked the insulators.

The Northern lines have worked well, though the white ants are very troublesome, causing over 25 per cent. of the interruptions; poisoned pins have been supplied but with doubtful benefit, as the ants in many cases, even if they leave the pin alone, eat the pole all round.

The total expenditure on maintenance and repairs for 1888 was £7,945 9s. 5d.

A new cable, 12 miles in length, has been laid between Magazine Island (Townsville) and Cape Cleveland.

The different telephone exchanges are in good working order. The numbers of subscribers are increasing in Brisbane; and some other towns, after falling off, have now much improved, being up to or above the standard number for provincial exchanges (32).

NEW PATENTS—1889.

14342. "Improvements in or relating to accumulators or secondary batteries for use in lighting railway carriages and other conveyances by electricity." J. C. Mewburn. (Communicated by La Société Anonyme pour le Travail Electrique des Métaux, France.) Dated September 11.

14366. "Improvements in or relating to arc lamps." W. S. Boult. Dated September 12.

14374. "Improvements in electric arc lamps." G. E. Dorman. Dated September 12.

14377. "Process of and apparatus for maintaining uniform current in electric lighting circuits." J. M. Bradford. Dated September 12.

14380. "Improvements in telegraphy and in apparatus therefor." G. Allan and J. W. Brown. Dated September 12.

14390. "Improvements in apparatus for transmitting electric currents to and from the commutators of dynamo-electric machines." G. E. Dorman. Dated September 12.

14448. "An electric chair for nervous and other diseases." E. Moross. Dated September 13.

14453. "Improved means for regulating the working of dynamo-electric machines." H. Harper and R. P. Wilson. Dated September 13.

14464. "Improvements in electricity meters." E. Batault. Dated September 13. [Date applied for under Patents Act, 1883, Section 103, 15th February, 1889, being date of application in Switzerland.]

14485. "Improvements in magneto electric bells or generators." A. Greenwood. Dated September 14.

14504. "An improved instrument for regulating electromotive force." W. H. Douglas and T. H. Parker. Dated September 14. (*Complete.*)

14551. "A primary battery solution." H. A. Henderson. Dated September 16.

14552. "Improvements in or relating to primary batteries." H. A. Henderson. Dated September 16.

14565. "Improvements in the method of and apparatus for recording telegraphic or other signs, more especially applicable to syphon recorder telegraphic instruments." G. Draper and W. H. Ash. Dated September 16. (*Complete.*)

14571. "Improvements in electrical switches." A. P. Lundberg. Dated September 16.

14589. "Improvements in printing telegraphs." F. H. W. Higgins. Dated September 16.

14590. "Improvements in electric bells." H. Groves and J. H. Stewart. Dated September 16.

14598. "Improvements in metallic circuits or conductors of electrical energy." H. F. Campbell. Dated September 17. (*Complete.*)

14601. "An improved connector for the elements of electric batteries." G. Macaulay-Cruikshank. (Communicated by S. H. Barrett, Massachusetts.) Dated September 17. (*Complete.*)

14636. "Improvements in apparatus for the automatic control and regulation of electrical currents for electric lighting and other purposes." G. Fletcher. Dated September 17.

14649. "An improved covering for steam pipes, electric wires, and the like." W. R. Lake. (Communicated by C. T. Lee, United States.) Dated September 17. (*Complete.*)

14656. "Improvements in electric glow lamps." A. Bernstein. Dated September 17.

14664. "Improvements in and relating to door-bell mechanism for mechanically ringing door bells, so as to imitate electric bells, to be applied in houses and other buildings." A. F. Rockwell. Dated September 17. (*Complete.*)

14666. "Improvements in electric conduits for street railways." J. W. Reno. Dated September 17. (*Complete.*)

14860. "Improvements in automatic telephone devices." C. G. Hoffmann. Dated September 20.

14867. "A method of and apparatus for manufacturing flexible metal-sheathed electrical conductors." O. Imray. (Communicated by F. Walton, Germany.) Dated September 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888.

10708. "Improved automatic electric cut-out." S. C. C. Currie. Dated July 2. 8d. Consists of two wires or pieces of metal, or other good conducting material, interposed in an electric circuit, and suitably supported at one of their ends by a connecting device, and with portions of the wires or pieces imbedded in an insulating substance or material of poor electrical conductivity, but susceptible of being melted at a low temperature with portions of said wires or pieces immersed in a conducting fluid contained in a bulb, tube, or other suitable vessel. Further consists of two inversely disposed wires or pieces of metal, or material of good conductivity, supported at one of their ends by a connecting device composed of insulating material, and portions thereof attached to or otherwise held by an insulated yoke, and said wires or pieces imbedded in a substance or material of high resistance, but capable of being readily melted, and with portions thereof immersed in a conducting fluid contained in a vessel, bulb, or other container, with a loop or band of insulating material circumscribing the vessel, or bulb, to permit the same to fall sufficiently when the circuit is automatically broken through the device by the melting of the substance or material of poor electrical conductivitity that said wires are imbedded in and supported in the vessel. 5 claims.

10709. "Improvements in insulators for electric batteries." S. C. C. Currie. Dated July 2. 6d. Claims:—1. A perforated corrugated insulating plate or diaphragm permitting of the free passage of the current as well as the free circulation of the liquid and gases in or through the perforations and around or along the grooves or recesses of the corrugations thereof, substantially as and for the purposes set forth. 2. A perforated corrugated insulating plate or diaphragm having the lines of corrugation lying in a vertical plane, substantially as and for the purposes set forth. 3. A perforated insulating plate or diaphragm formed with corrugations, substantially as and for the purposes set forth.

11529. "Improvement in indicators for electric light switches." W. Towle and W. E. Langdon. Dated August 10. 6d. Claim:—The application of luminous paint for the purpose of indicating the position of electric light switches, in the manner and for the purpose substantially as set forth.

11809. "Improvements in apparatus for measuring electric potential, applicable also for measuring heights and for meteorological purposes." A. H. Maurich, L. Carr, and D. Owen. Dated August 16. 11d. Refers principally to an arrangement or apparatus for measuring the effects of polarisation upon hermetically enclosed fluid dielectrics when submitted to the inductive influence of an electrified body. 4 claims.

12376. "Improvements in electric accumulators and in their manufacture." W. L. Wise. (Communicated from abroad by J. T. Van Gestel, of New York.) Dated August 28. 8d. Claims:—1. An element of an electric accumulator as described, and comprising a plate of a metal of low electric resistance, covered or coated with a layer of lead or alloy of lead, this layer being provided with a number of channels upon one or upon both sides of the plate, and these channels containing a suitable lead salt which serves as the active material. 2. The described modification of an improved element of an electric accumulator, according to which a core or internal body of metal, other than lead or lead alloy, is dispensed with. 3. The described method of manufacturing elements of electric accumulators, by forming a plate of copper or other metal of low electric resistance, applying upon this plate by hydraulic pressure, or by casting, a layer of lead or alloy of lead in such a manner as to form ledges or shelves; filling the spaces between the said ledges or shelves with an active material (any suitable lead salt); and after such filling bending the edges of the ledges or shelves so as to enclose and securely retain the said active material.

12860. "An instrument or means for the combined purposes of transmitting and recording speech or other sounds." H. Edmunds. Dated September 5. 6d. Has for its object to provide an instrument which can be used for the combined purposes of transmitting and recording speech or other sounds—that is to say, that it is adapted for use as a telephone and at the same time to make a record for subsequent reproduction of the speech or other sounds, after the manner of what is known as a graphophone. 1 claim.

13473. "Improvements in and connected with launches and other vehicles driven by electric primary batteries and motors." J. Sherrin and J. V. Sherrin. Dated September 18. 8d. The batteries are arranged on each side in the launch or other vehicle, and under seats arranged there so as to take up no necessarily available space in the middle. The batteries are supplied with the exciting liquid or liquids from a tank or tanks placed at a higher level in the stern or fore part of the vessel, and provided with a cock or cocks and pipes running along the lower inner sides of the batteries. 5 claims.

14426. "Improvements in electric switches." C. S. Snell. Dated October 8. 6d. The object of this invention is to ensure good electrical connection between a switch arm and the contact piece when the switch is in the "on" position, and this is effected by the use of a cast metal contact piece and a cast switch arm, the vertical faces of each of which are indented or recessed at intervals, the recesses in the contact piece being of the same vertical dimensions as the distance between the recesses in the switch arm, and *vice-versâ*. 2 claims.

1889.

11067. "Improvements in insulation for electric conductors." C. T. Snedekor. Dated July 9. 4d. The wire, cable, or other conductor to be insulated is first covered with a coating of liquid shellac, and, before this is dry, a coating or covering is applied to the conductor, consisting of some fibrous material, such as cotton, jute, silk, or other similar substance which has been saturated in a strong solution of alum. This coating is then allowed to become perfectly dry, after which a liquid glue of any preferred kind is applied, upon which, when hardened, is spread a thick coat of heavy varnish. While this varnish is yet damp a dust is applied, consisting preferably of about four parts of powdered or ground glass, one part powdered alum and one part powdered asbestos. The conductor is then again covered with a fibrous coating which has been first thoroughly saturated with a composition, or paste, consisting of linseed oil, litharge, white lead, ground asbestos and alum. This is again covered with fibrous materials which has first been saturated with a solution of alum and allowed to dry. To this dry fibrous coating is next applied a solution of any of the varnish gums dissolved in linseed oil, and before this coating hardens there is pressed into it a thin coat of asbestos fibre. When this is perfectly dry and hard the whole is thoroughly coated with varnish. 5 claims.

CORRESPONDENCE.

High v. Low Potential.

With Mr. Edison's recent flying visit to London the subject, the very important subject, of how best to convey electric currents for lighting, as well as for other practical purposes, has received another kick to the front, and it is to be hoped a final kick, before being practically and commercially settled, as separate from the conflicting conclusions of the mathematicians.

One point always worth remembering when considering this subject in the light of the oft-quoted, though useful comparison of hydraulics, is that we are not dealing with the movement of matter, in its ordinary sense, hence our conductors are smaller, and altogether more easily manipulated. The subject of insulation for life protection is undoubtedly important, and, although it occupies a foremost position for our consideration, the economical point of being able to use a maximum voltage without sparking across the insulation, is the "big job on hand." The danger to human life from electric currents is analogous in some respects to the use of gas at the present time. Upon what fine points the operation of hurriedly turning off an ordinary gas jet rests; let it be left the least open, and we stand a chance of not losing one life only, but perhaps a housefull. Let people understand that such-and-such things are dangerous, and they will attend to it; if they do not who is to blame? Are we to sacrifice our economical advantage because we think some person will be so foolish as to try for themselves what we tell them to be dangerous? It is the old story. If we do not learn from others' experience we are fools; if we do not learn from our own—well, I'll give it up.

Some people adopt the plan of building a brick house and putting an iron door in to ensure protection.

I am told that the 2,000 volt transmission system is working splendidly; in one case the cable insulation is improving every day, although several of the pipes have been under water some time, the insulation in the mains standing now at 15 megohms. That is an important point where iron socket pipes are employed to carry the cables, that the caulking should be well done. I wonder how a certain number of "coffins" in the vicinity of Piccadilly will be getting on. I hope *they* are water-tight (?). I had a chat with one of the "grave-diggers," who was letting some parts of a "corpse" know the strength of his arm, to enable him to get the "lid" down; and as an excuse for his rough treatment remarked that he thought "decomposition" was setting in, and that it was absolutely necessary to get them covered up before the inspector came round. I do hope, though, that they will cause no trouble for a little while.

This high-potential subject reminds me of what was once advocated for London's gas supply, viz., to convey it from Newcastle in a pipe under pressure.

Finally, let us go ahead with the high potential system, and find our limits—whether it be 2,000, 3,000, 5,000, or 10,000 volts or more.

Insulation.—Following up a suggestion I made in a letter some time ago, of employing three pipes, on the Ferranti principle, with the middle one a dummy, to prevent direct air passages between the conductors, would not a good hydro-carbon oil of about ·9 S.G., and free from acids or salts, run in between them, act as a better insulator than the solids? I am aware that oil has been employed, but I think not in this way.

James C. Richardson.

September 30*th*, 1889.

Electric Traction.

Is your correspondent, Mr. Jarman, prepared to advise his Syndicate to apply for an injunction to restrain the Sprague Company, the Thomson-Houston Company, the Julien Company, or anyone else from using two motors in the manner described in his specification, *e.g.*, to work one armature in one direction and the other in the opposite one. I take it that there is no difference in placing two motors side by side than in putting them at each end of the car?

William Houghton.

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Printed by E. [illegible], 16 and 23, Middle Street, E.C., and Published by the Proprietors, H. ALABASTER, GATEHOUSE & Co., at 22, Paternoster Row, London.